BURKE MUSEUM

FOSSIL PREPARATION LABORATORY MANUAL

21 January 2010

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Cover Image: The skull of *Hoplophoneus* sp. (UWBM 87094).

Figure 1. *The Burke Museum Fossil Preparation Laboratory (Room 17D).*

INTRODUCTION

The preparation of fossil specimens is a crucial aspect of paleontology. Since many fossils are found at least partly encased in rock, badly broken up or both, a lot of work is often necessary before proper study of the specimen can even begin. Matrix must be removed and pieces stabilized, cleaned and reassembled. As study of a specimen proceeds, a researcher may require further preparation of some portion of a fossil. Reconstruction of missing or partial elements may be needed if the fossil is to be displayed in a museum. Casts of a fossil may be desired. All of this is done in the prep lab.

Preparation labs are few, scattered, and generally located in the basements and back rooms of the institutions where they can be found. Traditionally, preparators have worked in near isolation from one another developing their methods as they went along and using tools designed for use in other industries. Much of that has changed. A few books have sought to compile preparation techniques. Preparator sessions at the annual meetings of the Society of Vertebrate Paleontology and enhanced communication through the internet have hastened the pace with which innovations spread through the prep community. Fossil prep has become enough of a market niche that there are now a few manufacturers who are developing and marketing tools and materials specifically for preparators. Some of these tools and many preparation techniques are becoming standard throughout the field but there will always be differences in the methods and materials in use between various prep labs. Some of these are dictated by the nature of the fossils most commonly being worked on. Others are matters of cost. Many are a reflection of preference or habit.

This guide is not meant to be a full course in fossil preparation. It focuses only on the tools, methods, and procedures in use at the Burke Museum.

Bruce Crowley
Christian Sidor

Figure 2. *Bruce Crowley assisting an undergraduate volunteer.*

PERSONNEL

Lab Manager

Bruce Crowley
Chief Preparator

Bruce Crowley
(206) 543-1856 Lab
bcrowley@u.washington.edu

Curators

Christian Sidor
Vertebrate Paleontology
Rm 8A, 221-4181

Liz Nesbitt
Invertebrate Paleontology
Rm. 8C, 543-5949

Caroline Strömberg
Paleobotany
Rm. 6, 543-0495

Collections Management

Ron Eng
Collections Manager
Room 7
543-6776

A complete list of **Burke Paleontology Personnel** can be found at:
http://www.washington.edu/burkemuseum/collections/paleontology/people.php

Also, take a look at the **Divisional Directory** in the basement hallway between rooms 21 and 22.

LAB BASICS

Hours of Operation

The fossil preparation lab is open from **9AM to 5PM, Monday through Friday** except for state holidays.

If the lab manager is sick, on vacation, or otherwise unavailable, volunteers will receive an email. In these circumstances, you may need to contact someone else in the Paleontology Division to be let into the lab. The lab telephone number is 206-543-1856.

It is important that volunteers maintain a set schedule of hours to be worked out in consultation with the lab manager.

Access

The prep lab is located in the basement of the Burke Museum, in rooms 17C and 17D. Because this is an area of the building that is not open to the public, anyone visiting the prep lab must have an alarm code or elevator key or must be guided by someone who has one. If you need to get in but do not have a key, the person at the loading dock reception desk can help you.

To leave during regular museum hours, simply use the elevator. Using the stairway always requires an alarm code.

Please do not bring friends or relatives to the lab without permission from a Burke staff member.

Paperwork

KEEP THIS SLIP WITH FOSSIL
UWBM # ______
Taxon ID: ______
Original Location: ______
Borrowed by: ______
Date: ___/___/___
Moved to: ______

THIS SLIP REPLACES FOSSIL IN COLLECTIONS
UWBM # ______
Taxon ID: ______
Original Location: ______
Borrowed by: ______
Date: ___/___/___
Moved to: ______

THIS SLIP TO COLLECTIONS MANAGER
UWBM # ______
Taxon ID: ______
Original Location: ______
Borrowed by: ______
Date: ___/___/___
Moved to: ______

Volunteer applications may be obtained either from the museum's volunteer coordinator or from the prep lab manager.

Time sheets are available on the small, wall-mounted table next to the door to room 17 and should be filed alphabetically in the loose-leaf binder that stays on the table. At the end of each day's work in the division, each volunteer should note the number of hours worked.

A **specimen tracking form** must be filled out whenever a specimen is removed from the collections or moved anywhere within the museum. This form needs to be filled out even if the specimen is just being taken to the prep lab for cleaning. The form, on pink paper, is self-explanatory: one part stays with the fossil, another replaces the specimen in the original location, and the third is given to the collections manager. Blank forms should be available in any of the collections rooms or from the collections staff.

All fossils must be properly labeled. If there is no number written on the specimen itself while it is undergoing preparation, it should be numbered as soon as possible and until then great care must be taken to see to it that it not be separated from its specimen tracking form.

A **fossil preparation lab conservation record** sheet should be filled out for each specimen that receives treatment in the lab. Sometimes new lines of research, display possibilities or damage will call for new work to be done on specimens that have been in the collections for many years. Since the materials that have been used by preparators have varied with time and individual preference and not all of the things that preparators may do to a specimen are readily apparent, it can sometimes be hard to determine how to proceed. For example: What is this adhesive that needs to be removed? Has this bone been bathed in acid? Which acid? The answers to such questions can determine what materials to use or avoid when new work is to be done on an older specimen. The original preparator may be unknown, unavailable or unable to remember. To lessen future confusion, it is best to keep a record of whatever procedures are performed on each specimen that undergoes treatment in the prep lab.

Date _________

Burke Museum Fossil Preparation Lab Conservation Record

UWBM# __________ [ ] other ____

Taxon ID ____________________ element _______________ storage location ________

Preparator _________________________

Initial condition: [ ] unprepared in jacket [ ] unprepared no jacket

[ ] partially prepared [ ] previously prepared

[ ] previous prep data on file date___________

[ ] previously used consolidant [ ] unknown [ ] known____________________________

Tools used: [ ] manual [ ] air scribe [ ] air abrasive with ______________

[ ] ___________ acid at ____ % [ ] other _____________________________

Solvent: [ ] acetone [ ] ethanol [ ] water [ ] other _______________________

Adhesive / Consolidant: [ ] paraloid B72 [ ] other _______________________

[ ] filler ___________________ [ ] paint _____________

Was a mold made? [ ] yes [ ] no

Separator on specimen: [ ] paraloid B72 [ ] other ______________________

Filler: [ ] carbowax [ ] cyclododecane [ ] plasticine [ ] other _________________

Mold material: [ ] platsil 71-20 [ ] other _____________________

Other procedures or materials used:

Comments:

Parking Redemption

Volunteers who drive and wish to park on campus will have to pay for parking at the gatehouse on the way in. Parking redemption is available for volunteers who work for at least **three hours** in a day but there is a trick to it: You must pay cash on your way in, get a redemption sticker from the Geology Division and show the sticker to the gatekeeper for a refund on the way out. To receive a parking voucher, see the Collections Manager in Room 7.

GETTING STARTED

What work will be expected of volunteers in the prep lab is quite varied. Specific preparation projects will involve a variety of fossil and matrix types and require a range of particular skills. For the safety of the specimens, it is essential that volunteers always know what to do and how to do it. If you are unsure how to proceed with a specimen, *ask questions*. If unfamiliar with the use of a particular tool, get instruction.

Project assignment: Preparation projects will be assigned to individual volunteers based on division priorities and the experience, proficiency and preference of the volunteer. Additionally, volunteers may be called upon to assist division staff or one another as needed. All will need to participate in maintaining the cleanliness and organization of the lab and its equipment.

Volunteers will usually be assigned a particular specimen to prepare. When a specimen is not actually being worked on it should be kept where it will not be creating problems for others (usually in an assigned space in the Lane Cabinet in Room 17D).

In the course of the day: In general, work stations will not be assigned to individual persons and where a volunteer will set up at the beginning of the day will depend on what space is available, whether a microscope is required and what can be worked out with anyone else who may be working in the lab. Particular tools are also not normally assigned, and if the lab is extremely busy this may require that personnel arrange the sharing of a tool. If this happens or if a needed tool is not available or cannot be found, the lab manager should be notified.

No one should move or remove tools or specimens already in place at a work station without getting clearance from the person who put them there or the lab manager.

If there is a need to use a pneumatic tool and no one else has yet opened the valve to provide compressed air to the work stations you will need to do so. The valve is on the pipe on the wall of room 17C between the dust collector and the fume hood (Fig. 3). As with all air and gas valves, perpendicular to the pipe is off and aligned with it is on.

Figure 3. *The main compressed air valve in Room 17C. Note that the air is turned on.*

If a significant amount of matrix is to be removed or if any other dusty operation is to be performed, the dust collector must be turned on. The dust collector is the large blue machine in the corner of room 17C. Pushing the green button turns it on and the red button turns it off. Ignore the red dial.

Figure 4. *The dust collector and its control panel in Room 17C.*

Adhesives and consolidants are in frequent use. These are usually solutions of Paraloid B-72 (an ethyl methacrylate co-polymer) and acetone. At the beginning of the day or at any time throughout the day, you may need to mix or to top off containers with acetone in order to have B72 of the needed viscosity. The small plastic bottles of acetone in use in the prep lab are refilled from containers of bulk acetone kept in a flammable materials cabinet in the back of the classroom next to the loading dock.

Clean up: Upon the completion of a project or at the end of a shift you must clean up your work station. This includes putting away tools, sweeping debris from the table and sweeping the floor. When sweeping up, always look closely at what you are discarding. Hopefully, nothing of importance will have gotten away undetected but the more things are double checked the better. If a lot of debris is being generated in the course of a shift, sweeping the work area at frequent intervals will minimize the chances for important little pieces to get lost. Adhesive spills should be cleaned up with acetone and if the table needs to be washed it should be.

Since the museum's janitorial staff has been instructed to leave the emptying of the prep lab trash cans to the lab personnel, you will need to empty them as they become full. Trash cans are to be emptied in the dumpster at the north end of the parking lot by the loading dock.

At the end of each month the prep lab receives a general, in depth cleaning.

At day's end: Complete the following check list at the end of every session.

1) Turn off the compressed air (Fig. 5) and any lights at your work station.
2) Return air scribe and other tools to their original locations.
3) Clean your work station (sweep dust, use acetone to remove any spilt glue).
4) Replace microscope lens cap and dusk cover.
5) Turn off dust collector (Fig. 4).
6) Check that all other electric equipment is turned off.
7) Record your hours.

If you're the last one to leave, please turn off the overhead lights, make sure that the main air valve (Fig. 3) is off, and lock the door on your way out.

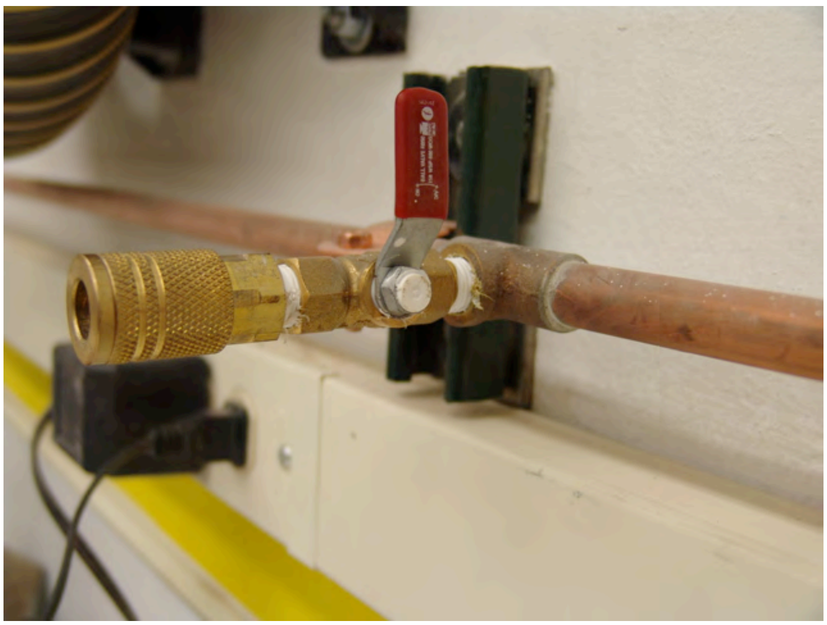


Figure 5. *This image shows a work station air valve in the off position.*

TOOLS OF THE TRADE

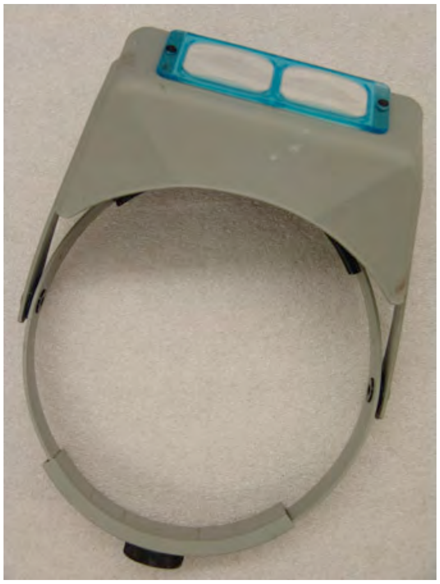
The prep lab personnel, including the volunteers, are expected to maintain the tools in good condition and repair. Oiling air tools, sharpening points, mixing adhesives and such chores should be part of your daily routine rather than something you leave for someone else to do. As you gain proficiency with a particular tool, you may learn more advanced troubleshooting and repair methods. If a tool seems to need repairs that you cannot give it, tell the lab manager.

Where to find it?

The prep lab is overflowing with equipment and supplies, so don't be surprised if it takes a while to figure out where everything is located. If you don't see what you're looking for – ASK! *And PLEASE put everything back where you found it.*

Equipment or Supply	Location	Use(s)
Abrasives for Swam Blaster	Under center table	Preparation
Acetone (small amounts)	Center table	Preparation, Conservation
Acetone (bulk)	Safety cabinet in classroom upstairs	Preparation
Air scribes / hammers	Lane Cabinet in 17D (top 3 drawers)	Preparation
Air scribe parts	Green cabinet next to central table (top shelf)	Preparation
B72 beads	Large grey cabinet (3rd shelf)	Conservation
Brushes (for glue)	Center table	Preparation, Conservation
Brushes (for cleaning fossils)	Center table	Preparation
Brushes (for paint)	Tan wall-mounted cabinet	Preparation
Bulbs (for microscope lamps)	Tan wall-mounted cabinet (top left)	Preparation
Carbide rod (for pin vises)	Center table	Preparation
Carbowax & related equipmnt	Tan cabinet next to central table	Preparation
Cast cutter	Large gray cabinet (3rd shelf)	Preparation
Casting resin (2 part)	On or under counter on W wall of 17C	Casting and Molding
Dental drill & related	Tan cabinet next to central table	Preparation
Dental tools	Center table	Preparation
Dremel-type tools	Tan cabinet next to central table	Preparation
Dust masks	Large gray cabinet (2nd shelf)	Safety Equipment
Ear plugs and muffs	Large gray cabinet (2nd shelf)	Safety Equipment
Ethafoam		Storage
Glue (premixed B72)	Center table	Conservation, Preparation
Heat Gun	Tan cabinet next to central table	Preparation
Hydrocal	Under center table	Casting and Molding
Molding clay	Left of fume hood in 17C	Casting and Molding
Molding silicone	On or under counter on W wall of 17C	Casting and Molding
Nitrile gloves	Large gray cabinet (2nd shelf)	Safety Equipment
Optivisors and lenses	Large gray cabinet (2nd shelf)	Preparation
Pin vises	Center table	Preparation
Plaster	Under center table	Preparation, Storage
Safety glasses	Large gray cabinet (2nd shelf)	Safety Equipment
Sand (loose)	Under center table	Preparation, Molding
Sand bags	Under NE corner of work counter	Preparation
Specimen trays		Storage

NB: If you notice that the lab is running low on something (or has run out), make a note of it on the small white board on the gray cabinet and tell the lab manager. Likewise, if you break something that you cannot repair, tell the lab manager.



Magnification

Magnification is essential whenever working at or near the surface of a fossil specimen. The fossil lab has three types of magnification:

Low Power—Some of the safety glasses are bifocal to provide slight magnification. Most low-power magnification in the lab is provided by Optivisor hobby glasses. These have interchangeable lenses of varied strength and are worn on the head.

Medium Power—There are two ring lights with an embedded magnifying lens. These provide excellent illumination of the working area and have the added bonus of shielding you from flying chips of rock.

High Power—There are five microscopes available for the high-power magnification necessary for fine work at the fossil surface. These are expensive, precision instruments and should be treated with care. <u>When not in use, they should be covered with a dust cover and lens cap</u>. To prolong the longevity of the accompanying fiber optic light sources, please turn them off when not in use.

If all five microscopes are being used, there are two additional 'student' microscopes. These are perfectly serviceable microscopes, but will appear darker once you're used to the excellent Zeiss or Nikon optics.

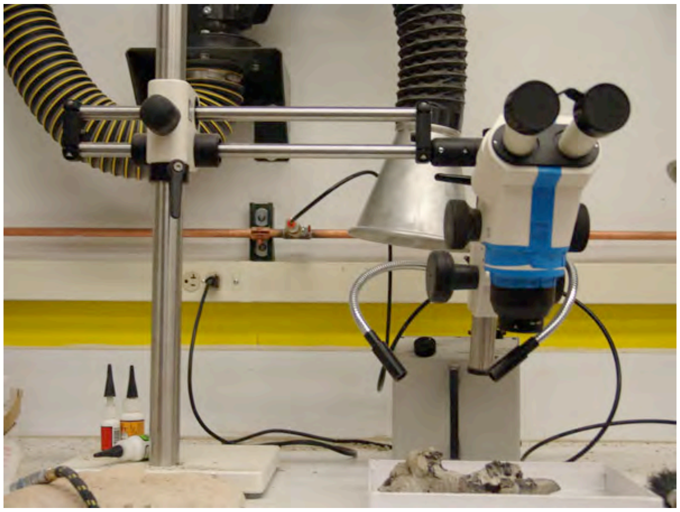


Figure 6. *Low, medium, and high power magnification.*

Hand Tools

These include a variety of dental tools, needles, and pin vises (see below). These are mostly used with very delicate fossils that could be damaged by vibration.

The pin vises hold needles made from carbide rod. Though carbide is quite hard and won't be easily dulled, it is very brittle. Tips will break off and need to be sharpened. New needles will need to be made from time to time. A supply of carbide of various diameters is maintained for making needles. To make a needle, score the rod at the desired length with the diamond wheel on a Dremel and break it off. Then, with the rod in the pin vise, give it a point with the green, silicon carbide wheel on the Dremel.

A variety of diamond sharpening stones are available to maintain fine points on the hand tools.

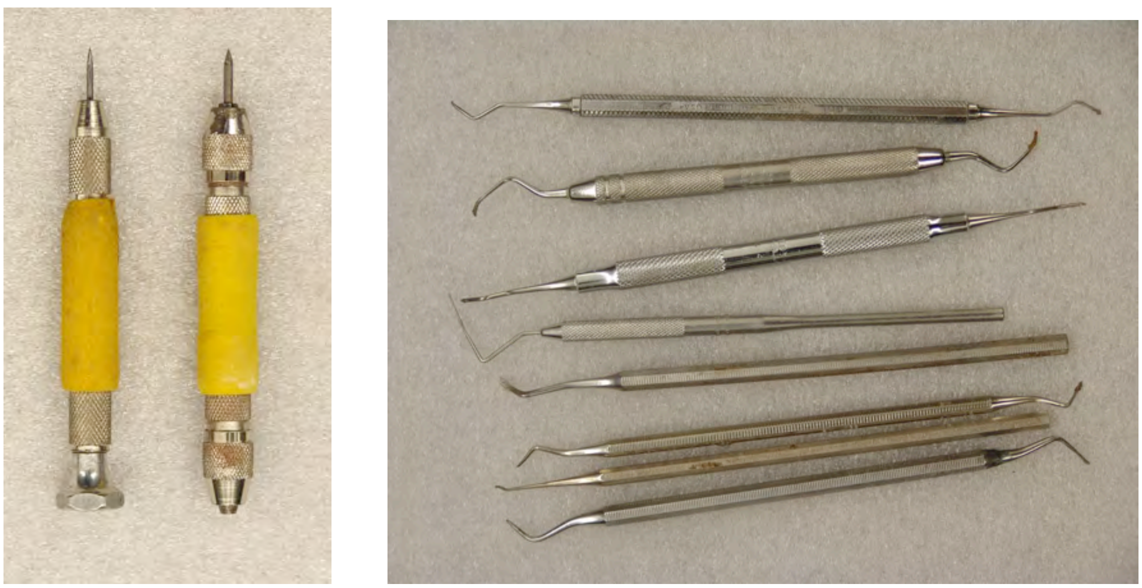


Figure 7. *Pin vises and dental tools.*

Air Scribes

Air scribes (air hammers) are the most frequently used power tools in the Burke prep lab (Fig 8). They are a sort of scaled-down jackhammer that functions by chipping away the matrix with sharp strokes from a carbide-tipped chisel or stylus. The force they use to break the rock is just as good at breaking fossils so these tools must be <u>used with care</u>. The hoses for the air scribes do not last forever and they tend to breach, possibly without warning, when there is compressed air in the line. Therefore it is best to <u>shut off the air valve when an air scribe is left unattended</u>.

NB: All air scribes should be <u>oiled once per day</u> by putting a drop (short shift) or two (full day) of air tool oil either in the back of the tool or in the end of the air hose at the start of the day.

Figure 8. *The three types of air scribes: CP, ARO, and Microjack*

For rapid removal of matrix well away from the fossil, choose one of the silver colored **CPs** (Chicago Pneumatics made the original, although some of ours are from Texas Pneumatics and Murray Engineering). CP air scribes have a knurled ring that controls the variable speed of the impacts in addition to acting as the on/off switch. If the scribe doesn't work when you turn the ring, try tapping the barrel (or, carefully, the tip) against the table.

To oil the CP directly requires a couple of wrenches be used to unscrew the tool from the fitting at the end of the air hose. Put a drop or two of air tool oil in the back of the tool and reattach it to the hose. The easier (and acceptable) alternative is to put the oil in the end of the hose before attaching it to the fixed air line coupler.

Changing the stylus or o-rings and some minor troubleshooting on the CP can be easily learned but since the lab supervisor needs to monitor the condition of the tools and the need for replacement parts, new volunteers having trouble with the tools should bring the problem to the attention of the lab supervisor and learn troubleshooting directly as occasions arise.

The **ARO** is a tool similar in size and appearance to the CP. In precision and matrix removing speed it is intermediate between the CP and the Microjacks. Holding the knurled base of the tool while turning the body turns it on and off. Like the micro jacks, the ARO has an easy release fitting on the connection to the hose, which makes it easy to oil the tool directly. Pressing the two orange rings together allows the hose to be pulled free from the tool. A drop of oil for each days work can then be placed into the back of the tool. The hose is then pressed back into the orange fitting until you feel it seat.

Microjacks are the primary air scribes for working close to the fossil surface. They are available in a variety of sizes, none of which is large and powerful enough for quick matrix removal and all of which should be used with magnification. Those available range from the MJ-2 (smallest) to the MJ-5 (largest), which basically correspond to their power. Tool size is labeled on the on/off valve.

The microjacks all have an easy release fitting on the connection to the hose which makes it easy to oil the tool directly. Pressing the two orange rings together allows the hose to be pulled free from the tool. A drop of oil for each days work can then be placed into the back of the tool. The hose is then pressed back into the orange fitting until you feel it seat.

Microjacks only work at a single speed. If turning the valve does not start the tool, try gently tapping the barrel of the micro jack against the table. If that doesn't work, try loosening the tip with a slight twist of the knurled forward portion of the tool. If it still doesn't work (and you have checked to see that the air line is open) or if it keeps stalling out, the most likely problem is a degraded o-ring. To replace an o-ring, turn the knurled portion of the micro jack to unscrew it completely. The o-ring fits inside the base of the stylus. Neither the o-rings nor the styli are interchangeable between the various sizes of micro-jacks, so you must choose the one of the appropriate size. Replacement parts are kept in the green cabinet next to the central table.

More about air scribe use may be found in the Techniques section (p. 20).

Rotary Tools

Some fossils are too fragile to withstand the amount of vibration that can result from removing nearby matrix with the air hammers. In such cases, rotary tools can be used to grind away matrix to where preparation can be finished with hand tools. This must be done with extreme care since the rock to fossil interface can be very hard to recognize in a surface that has been ground.

The **Midwest high speed dental drill** (Fig. 9) is a pneumatic tool that is operated by a foot pedal. It must be kept well lubricated and must never be attached to an air line without a regulator set to 30 psi. To lubricate the dental drill, remove the tube from the brass fitting on the handpiece and place three drops of Midwest Plus Handpiece Lubricant into it. Once the tube has been reconnected, run the handpiece for 30 seconds.

Dust produced by the dental drill is extremely fine. It is an essential safety measure that the dust collector be turned on and that an intake is positioned to suck away the dust whenever this tool is in use.

Figure 9. *The Midwest high speed dental drill*

The prep lab also has two **Dremel** electric rotary tools. These are larger and more coarse than the dental drill and are not generally used for matrix removal at the Burke. They are mainly used for sharpening the points on hand tools and air scribe stili and for grinding away flash on newly made casts.

Air Abrasive (Swam-Blaster)

The **Swam-Blaster** air abrasive (Fig. 10) is a very small-scale sandblaster with four main components: the abrasive powder, Swam-Blaster, work chamber and dust collector.

The ideal use of the air abrasive method is the removal of soft matrix from much harder fossils when there is considerable visual contrast between the two. Careless technique or use of too aggressive an abrasive can quickly cause severe damage to fossils. The powders will bounce off skin but rings and watches should be removed and blasting of fingernails should be avoided.

Figure 10. *The Swam Blaster air abrasive unit and its dedicated Torit dust collector.*

The air abrasive system does not have a fixed line for compressed air so the first step is to connect a hose from one of the air outlets along the wall to the inlet line on the Swam-Blaster. The Swam-Blaster, work chamber and dust collector are all plugged into a power strip on the floor under the work chamber. Flipping the switch on the power strip will activate all components.

Several types of abrasive powders are available. They range from softer sodium bicarbonate and dolomite to harder aluminum oxide and silicon carbide. Only one powder at a time can be loaded into the Swam-Blaster.

Once powder is loaded into the machine and the machine is switched to the 'on' position, air pressure and powder flow can be regulated with the available controls. The foot pedal starts the flow of powder from the orifice at the end of the hose in the work chamber.

Do not introduce abrasive into the work chamber if the dust collector is not on. Hoses, pinch valves and nozzles within the Swam-Blaster are all rather easily eroded so prolonged use of the air abrasive will likely require a bit of troubleshooting.

Continuous use of the air abrasive will quickly fill the dust collector, requiring that it be emptied periodically. Anyone using the Swam Blaster should know how to empty the dust collector.

More about air abrasive use can be found in the Techniques section (p. 20).

Adhesives, Consolidants and Gap Fillers

It seems that no aspect of fossil preparation has been more subject to change over the years than the types of materials used as adhesives and consolidants. Materials that had seemed to work well were found to degrade to an unacceptable degree with time. Improved materials and extensive testing have allowed preparators to indulge in increasingly rigorous conservation ethics when it comes to choices between available adhesives.

Paraloid B72 (Ethyl Methacrylate co-polymer) is the preferred consolidant and adhesive in the Burke Museum lab. It comes in the form of clear plastic beads that are kept in white plastic pails in the large cabinet in 17D. For use, it is mixed with acetone to form a fluid of the desired viscosity. Solutions of different thicknesses are kept in the lab in small, color-coded jars. Since evaporation will occur whenever a jar is open, <u>lids should be closed</u> except when the Paraloid is actually being used. Even so, it may prove necessary to add acetone from time to time to maintain the desired solution thickness.

B72 Paraloid Color Chart

Yellow	Thickest, used for gluing large pieces together
Orange	Medium, used for gluing small pieces
Green	Thinnest, used as a finishing coat
Blue	Acetone only, used to remove excess B72

To prepare the Paraloid for use as an adhesive we fill a quart jar half full with acetone and add Paraloid beads until the jar is nearly full. It takes a few days for the beads to fully dissolve even with occasional stirring. This will prepare a thick syrup suitable for use as an adhesive.

Thinner solutions of Paraloid for use as a consolidant can be mixed directly from the thicker syrup by adding acetone and stirring it in. This can be painted or dribbled onto a specimen to consolidate it. The thinner the solution, the deeper the penetration will be. If matrix or loose sediment has been adhered to a specimen by consolidation with Paraloid it can easily be removed by saturation with acetone.

More on gluing with Paraloid can be found in the Techniques section (p. 20).

Large cracks or gaps may need to be filled to increase the stability of a specimen or to improve its appearance if it is to be displayed. One method of gap filling is to pack the gap with cotton linters and then dribble a thin Paraloid solution to saturate them. Paraloid does not accept paint well. If it is intended that the gap be painted over for display purposes, it should be filled with **Durham's Water Putty** or plaster.

Other Glues

Ease of use, rapid set time and exceptional bond strength make cyanoacrylates (superglues) a tempting option for fossil preparation either as a consolidant in the field or as an adhesive in the lab. The fact that this is the only class of adhesives that is being actively marketed to preparators (as Paleo-Bond) adds to that temptation and bolsters a sense of their acceptability.

This lab strongly discourages the use of cyanoacrylates as either a consolidant or an adhesive. They have extremely poor reversibility so their removal cannot be accomplished by simply applying a solvent and once they have coated a portion of a fossil they cannot generally be removed without lifting away a surface layer of the fossil.

Acids

Heavily carbonate matrix will dissolve or disaggregate in acids. Immersion in an acid bath can be a good way of removing matrix from fossils but it requires close monitoring since the susceptible chemistry will likely have permeated the bone as well as the matrix. It is a good idea to begin by testing some of the matrix to determine which acid to use, at what strength and for how long. Acid baths in use at the Burke are **acetic** (less aggressive) and **formic** (more aggressive) acids in a 5%-7% solution. All bone exposed on the surface of the specimen must first be coated with B-72 to protect it from the acid. The specimen should then be fully submerged in the acid solution. A single immersion usually lasts from two to four hours followed by a water rinse of similar length. Once the specimen is rinsed and dried, loose matrix can be removed mechanically with hand or air tools. Newly exposed bone is then coated with B-72 and the process is repeated.

The need to protect the bone as it becomes exposed requires that only a thin layer of matrix be dissolved with each immersion so preparing fossils with acids can take a much longer time than one might expect. As with other prep methods, patience and care are required.

All work with acids must be done in the fume hood and impermeable gloves must be worn. When mixing acids with water to prepare bath solutions, the acid must be added to the water.

Casting and Molding

It is frequently necessary to make casts of fossil specimens either for research or education/display purposes. What techniques and materials will be used for the molds and casts will be dependent upon the size and complexity of the specimen, the degree of detail required and the time and money available for the project. Most recent molds at the Burke have been made from **PlatSil 71 RTV silicone rubber** and most casts have been made from **Easyflow 60 liquid plastic**. Both are two part concoctions made by Polytek Development Corporation and the resulting casts are of durable, lightweight plastic and of research quality.

Other tools and materials used in making casts include sulfur-free plasticene clay, clay working tools, vacuum pump and chamber, hydrocal and fiberglass.

An **overview of the methods** can be found in the Techniques section (p. 20) but if you have not previously worked with these materials you should seek instruction from someone in the lab who is familiar with them.

More on Casting and Molding can be found in the Techniques section (p. 20).

Other Equipment

There are a few pieces of prep lab equipment that require monitoring and periodic maintenance. The lab manager will generally deal with these maintenance duties but may need to delegate some of them if away from the lab for an extended period.

Dust gathered by the black and yellow articulated tubes in room 17D (see Fig. 1) ends up in the **dust collector** (Fig. 4) in the blue cylinder at the base of the hopper. The cylinder should be examined at the time of each month's general lab clean up and emptied if more than one quarter full. The Swam Blaster has a separate dust collector which fills quite quickly when it is in use. Anyone using the Swam Blaster should see to it that emptying the dust collector is included in their instruction.

The compressed air line in room 17C has a **filter** and **air dryer** between the main shut-off valve and the dust collector (Fig 11). The **filter** (the smaller of the two black cylinders) has a clear glass port on top with an orange plastic indicator which will remain visible once the filter element becomes clogged and needs to be changed. Replacement filter elements are in a box on the floor beneath the filter. Replacing the filter element should be necessary about once a year. The **air dryer** is filled with blue silica gel desiccant beads which turn pink when saturated. A glass port low on the cylinder allows the bead color to be monitored. When they turn pink, which will happen a couple of times a year, the cylinder must be removed and the saturated beads replaced by the blue ones in the large jar on the floor beneath the air dryer. The saturated beads are then dried in the oven on the counter in room 17C until they turn blue again and they can refill the jar for use the next time. <u>The main air shut off valve must be closed and all air purged from downstream before either the filter or the dryer unit is removed.</u>

Figure 11. *Air filter and air dryer*

The **air compressor** is located in the mechanical room at the opposite end of the basement hall from the prep lab. The facilities manager has the key to the mech room. Water must be bled from the compressor tank at roughly monthly intervals. There is a yellow handled valve to an outlet pipe at the base of the tank. Opening the valve allows the water to escape to the drain on the floor. The compressor will kick on as you are doing this. That's OK. When the water is purged be sure to close the valve completely.

The sink in room 17D is equipped with a **sediment trap**. Trapped sediment will build up in the metal box on the floor to the point where it will eventually prevent proper drainage. At that point the sink will back up or the box will overflow creating a local flood. How often the sediment trap needs to be emptied depends on the rate at which sediment is being washed down the sink. To clean it out, unscrew and remove the bolts at the four corners of the lid and remove it. Inside is a metal tray that can be lifted out and its removable screens can be washed off. Past practice has been to do this at the end of a day, rinsing the tray and screens in the standing water in the trap box. After it has had overnight to settle, the water can be ladled out and the mud at the bottom then scooped out and tossed in the dumpster.

TECHNIQUES

Air Scribes: Learning to operate the air scribes is pretty easy. Gaining proficiency in their use can be difficult. Here, as with so much of prep work, patience is the most critical factor.

Air scribes should be used with care, concentration and, if near the fossil, magnification. In addition to direct impact, there are a couple of other ways that these tools can damage the fossils. Stresses and vibrations might run through the specimen causing or extending breaks even well away from the immediate area where the tool is being applied so the specimen must be checked constantly for cracks until it's clear that it can handle the impact. Air scribes tend to blow air toward the point of impact. This helps to keep the area of the work clear but if the fossil is quite fragile, there is a chance that too strong a flow of air might cause damage. It may be necessary to further stabilize the fossil with consolidant or switch to a different type of tool.

The stylus is extremely hard but somewhat brittle. To reduce the risk of breaking off the tip, it is best to work in the direction that the tip is pointed rather than sweeping it from side to side and to not get too greedy about what size of chip you take off with each stroke. Though you may feel a temptation to hurry the work by adding extra force from your hand, it is best to let the tool do the chipping and to just hold it firmly without pressing it hard toward the specimen.

In general, the scribe is held at an angle of about 60º to the work surface and greatest stability is achieved if contact with the specimen can be maintained by the other fingers of the hand holding the scribe and the specimen is further stabilized by holding it with the other hand.

Fossils should always be placed on a sandbag(s) while being prepared with an air scribe, for two reasons: 1) the sandbag distributes the weight of the fossil and absorbs some of the vibration, and 2) it allows you to easily spin, reposition, or angle the specimen under the microscope.

JP Cavigelli (in Brown et al., 2009) and Bill Amaral (in Leiggi and May, 1994) have written very useful articles that detail fossil preparation under a microscope.

Rachel Simon, who has been preparing fossils in the Burke Lab for over 3 years, has contributed these tips:

- The higher the magnification of the scope, the easier it is to distinguish the matrix from the surface of the bone.
- Hold the air scribe with your dominant hand. Your other hand may hold the specimen steady on the sand bags or tilt the specimen as needed, but the specimen should otherwise remain still while the air scribe works to remove matrix.
- When starting to prepare a new specimen, look for any areas of bone that are already exposed. Begin preparing at these exposed surfaces.
- If you are having a difficult time distinguishing fossil from matrix, squirt some acetone onto the specimen. Matrix often becomes darker when it is covered with acetone while the fossil remains the same value. Also, the acetone on the bone tends to dry faster (because bone is porous).
- Move the air scribe in tiny, delicate strokes in a uniform direction towards the exposed fossil surface. If part of the fossil is accidently prepared away, try to recover the piece and reapply it with thin B72 glue.

- Always let the air scribe do the work. Allow the air scribe to set the pace based on how well it pulverizes the matrix. Do not force the air scribe through the matrix as this can not only hurt the air scribe, but risk damage to the specimen unseen below the matrix. A good way of testing this is that the sound produced by the air scribe should always be the same pitch. If the pitch gets higher, you're pushing too hard.
- Never try to predict where the surface of the fossil will be below the matrix. Fossils become distorted and cracked over time, so fossil surfaces are often uneven and unpredictable. Always remove matrix slowly and cautiously to avoid accidentally puncturing the fossil. Always prepare from exposed fossil surfaces and work your way out.

Air Abrasive (Swam-Blaster): Which abrasive powder to use and what air and powder flow settings will be optimal can vary widely depending on the particular characteristics of a specimen and its matrix. Experience and trial and error are your best guides. Try to experiment with extra matrix in determining how to proceed.

The abrasive spray should be directed at an angle away from the specimen. A slow, waving motion of the nozzle can reduce the incidence of pitting which can send abrasive into uncontrolled ricochets. The distance that the nozzle is held from the specimen will affect both the strength of the abrasion and the size of the area being abraded.

Try to hold off cleaning the surface of the fossil until you are comfortable with your ability to control the many variables which determine how safely and smoothly a particular specimen can be cleaned by the air abrasive technique.

JP Cavigelli posted a useful presentation of suggested air abrasive techniques at:
http://www.vertpaleo.org/education/documents/Cavigelli_2007.pdf

Adhesives and Glue: To glue two pieces of a fossil together, paint each side with a thin coat of the thick Paraloid. Press the two, glued pieces together and, using gravity, sandbags, rubber bands, a sand box or whatever else works, position the repaired fossil so that the joint will remain in stable contact. *Then walk away from it.* The most serious disadvantage that Paraloid has as an adhesive is its slow set time, which can range from a few minutes for a very small joint to more than an hour for larger ones. It is a matter of waiting for all of the acetone to evaporate from the solution. A particularly large, thick joint should be left overnight. Once the repair has dried, acetone can be used to clean away any excess Paraloid that may have extruded from the joint.

Although Paraloid B72 is the Burke's default adhesive, there are other options that may be preferable in some cases. Amy Davidson (in Brown et al., 2009) has written two articles that provide a useful overview of the characteristics of the types of adhesives in use in various labs.

Molding and Casting: A variety of techniques and material are used to make replicas of fossils (see Chaney and Goodwin's chapter, in Leiggi and May, 1994). The following includes some techniques adopted at the Burke Museum, but experimentation with other materials and methods is ongoing.

The first part of making a cast is to prepare the fossil by filling any cracks or gaps into which the liquid silicon might penetrate in such a way that removing it, once it sets up might damage the specimen. For thin cracks, B72 will suffice but wider gaps are filled with carbowax or other materials. The entire specimen is then coated with a layer of thin B72 to aid separation.

The next challenge is to ponder how best to go about making the mold. Molds are generally made in two parts that fit snugly together leaving a central void the precise shape of the fossil. Determining where to put the seam can be simple and straightforward in some cases such as with a typical limb bone or it may be rendered dauntingly complex by the presence of long projections, deep undercuts, foramina and particularly delicate structures. Once a seam line has been decided upon, the procedure is to bury the specimen up to the seam line in sulphur-free plasticine clay with a clay dam around it. The surface of the clay should be provided with dimples that will create numerous interlocking points for registering the two sides of the finished mold. A specimen number impressed into the clay at this point will make the mold easier to identify in the future.

The two components of the PlatSil are mixed thoroughly in a one-to-one (by volume) ratio and placed in a vacuum chamber for about three minutes to remove bubbles and the mixture is then poured over the fossil. Blowing it at this point with pressurized air will remove tiny bubbles and push the liquid rubber into undercuts and interstices. Once the PlatSil has cured, additional layers will likely be necessary to fully cover the specimen being molded with a desired thickness of silicone. When that has been achieved, a hydrocal mother mold is poured over the silicone. For larger molds it may be necessary to reinforce the hydrocal with fiberglass.

The completed half mold is then flipped over and the clay is removed completely. At this point, the silicone mold surface must be painted with slightly thinned liquid dish soap to prevent the second half from adhering to the first when it is poured. A clay dam is built around the first half mold and then the second half is made in the same manner as the first.

Once the mold has been completed and the specimen has been removed, casting can begin. Dyes can be added to one component of the plastic before the two components are mixed. The components must be mixed thoroughly and once the mixture begins to set, it will harden rapidly. Best results can be obtained by preparing small amounts of the plastic and coating one side of the mold at a time while the two sides are separated. This allows close inspection to get rid of bubbles and see that surfaces are well coated. Once the two sides are coated, pour freshly mixed plastic into one side of the mold, clamp the two sides together and rotate the mold to distribute the plastic while it hardens. Pay particular attention to coating where the seams will be.

When the plastic is sufficiently hardened, the cast can be removed from the mold and the flash can be cut or ground off.

SAFETY

The prep lab can be a dangerous place so safety is a big concern. Many of the processes in the prep lab generate a lot of noise, dust or flying rock chips. Some include the risk of messy or dangerous spills. All lab personnel are required to use the provided safety devises wherever they or anyone near them creates a hazard.

Most **safety equipment** (safety glasses and face shields, respirators, ear plugs and muffs and nitrile gloves) is found in the large gray cabinet in 17D. Thicker gloves may be found in one of the drawers in the small cabinet under the air abrasive unit. Lab coats are found on hangers in room 17C.

There is a **fume hood** in room 17C for any work with acids, fire or volatile chemicals that release hazardous fumes. The fan in the fume hood should be left on at all times with the door at least partly open. It can be adjusted to the higher air flow setting if necessary.

The sink in 17C is equipped with an **eye wash attachment** and there is an **emergency shower** located behind the door.

The six **dust collector intakes** associated with each work station in room 17D (Fig. 1) must be in operation whenever quantities of dust are being generated. Each of the intakes is opened or closed by a lever near the opening. As with all air valves, directing the lever parallel with the hose opens air flow and setting it perpendicular closes it. When using the dust collector, be sure that the intake is positioned near the source of the dust and that the valve is open. The air abrasive unit in 17D is connected to a separate dust collector.

There are **first aid kits** in the hall outside room 19, over the sink in 17C and on the south wall of room 17D. There are band aids and other first aid materials in the cabinet over the counter in 17C and in the left portion of the wall-mounted cabinet in 17D.

Material Safety Data Sheets (MSDS) and a University of Washington Laboratory **Safety Manual** are on a shelf in room 17C. Anyone using the prep lab should begin by familiarizing themselves with the location and use of all safety materials (a good idea wherever you are and whatever you're doing).

Proper Usage—Many of the tools, materials and chemicals in the prep lab can cause serious injury if carelessly or improperly used. It is essential that lab workers learn the proper use of and necessary precautions to be taken with them before using any tools or materials in the lab. Risks that you might be willing to take in your own home might be unacceptable in a state-run facility. If you don't know how to use a particular piece of equipment – ASK!

Please report hazards or unsafe conditions to the lab manager immediately.

IN AN EMERGENCY

In case of a fire, serious accident, or any such emergency requiring an immediate response, call 911. Emergency procedures are outlined in a flip-book next to the telephone detailing what to do in the event of everything from bomb threats to earthquakes. Please take the time to look through it before an emergency occurs.

If the fire alarm sounds it will be loud and a light will flash on the alarm fixture on the prep lab wall. You will recognize it. Do not ignore it. There is an emergency exit door to the outside at the end of the hall near room 17. This exit must be used in case of fire or some such extreme emergency but the door cannot be opened without setting off one of the monitored alarms (a big hassle and expense if the fire department isn't already on its way to the building). When the museum is evacuated, everyone is directed to gather near the bus parking area near the southwest corner of the building and to wait there until told that it is safe to return to work.

SUMMARY OF ROUTINE TASKS

Daily

- Open the prep lab and turn on the lights.
- Open the main air valve to let air into the air lines.
- Observe all relevant safety procedures and maintenance protocols for whatever tools and materials you are using.
- Clean your work area at the end of each project and at the end of the day.
- Empty trash cans as needed.
- Put away all tools and properly store work in progress.
- Turn off all lights and electric appliances (except for the fume hood fan) and lock the door to the hallway.
- Record your hours.

Bimonthly

- Bleed water from the compressor tank in the mech room.
- Check dessicant in air dryer and replace as needed.

Monthly

- Fully clean lab of accumulated dust and clutter.
- Check dust collector bin and empty as needed.

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Matt Brown's Websites
http://fossilprep.org/
http://preplounge.blogspot.com/

RMDRC Prep Lab
http://rmdrc.blogspot.com/

PaleoTools
http://www.paleotools.com/

* Copies available in the Lab Manager's office.