PREPARATION OF SMALL VERTEBRATE FOSSILS

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1972

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INTRODUCTION TO PREPARATION:

Even though a fossil specimen has been preserved for several hundred million years, it is a delicate and irreplaceable jewel when it is uncovered from the protection of the earth. Some rocks remain hard as concrete, seeming unwilling to divulge its content. These often arrive at the preparation lab much as they were found. Others, with a tendency to crumble, are secured various ways. Most are given a coating of thin glue or varnish to keep the rock from deteriorating and prevent small pieces of bone from falling off. This coating may only be on the surface or may actually permeate the rock, strengthening the whole. Weak specimens are further wrapped with paper and plaster of paris bandages, much like a broken arm.

However your specimen has been preserved, stop to think about its uniqueness and about the many hours you will spend working on it. DO NOT BE IN A HURRY!

Look at the specimen long and carefully. Determine how many pieces there are, how they fit together, what parts are most important to protect or expose. If you are preparing for another person, find out what that person is interested in. When a specimen is in several blocks of rock (called "matrix" usually), you may find it useful to make marks with India ink on the blocks to show how they fit together. Ink lines crossing the crack of separation between the two blocks can be very useful later or after you have started removing matrix. Photographs of the specimen as you receive it may also be helpful. I usually photograph specimens at various stages and mark on the photographic prints notes on what has been removed (I number the pieces) and what has been lost (such as a tiny tooth-cusp or corner off a piece of bone). Ink sketches can be very helpful also.

Before poking into anything make sure all bone is secure. It need not all be coated with varnish unless it is fragile. In fact, you may want to <u>remove</u> some glue or varnish if it is so thick as to obscure the bone.

Now you can poke at some of the matrix with a needle, determine how hard it is and what tools you want to use. As you work keep the specimen clean of dust and matrix fragments so you will notice immediately if any new bone turns up. Keep your tools sharp and your eyes clear.

PREPARATION:

Recognizing Bone

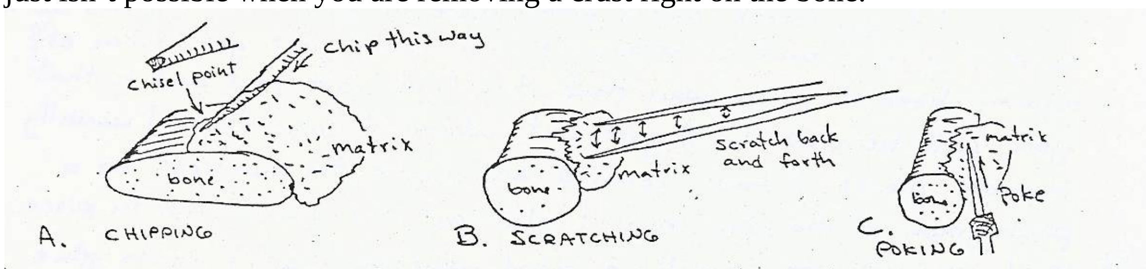
Specimens of vertebrate remains vary a lot. Fossil bone can be soft, hard, dark, light, flaky, crumbly, solid, brittle. It may be very easy to distinguish from matrix (light colored bone, dark matrix), or it may be practically indistinguishable from the rock encasing it. One of your first tasks is to learn what is bone and what isn't. One way in which bone is usually different from matrix is in texture. Bone usually has a relatively smooth, almost vitreous (glass-like), non-granular surface. Matrix is sometimes non-granular, but it is usually dull-looking under a microscope. Bone is often encrusted with a mineral coating, such as calcite or hematite, which may give it a granular appearance, but usually this crust may be scraped or poked off, exposing a clean bone surface. Fossil bone has the same appearance as the bone of recently dead animals – except for the color and weight it is sometimes hard to tell them apart.

A note of CAUTION: the ends of long bones and portions of other bones are not always completely ossified, so that there might have been cartilage present rather than bone. This cartilage may or may not be preserved, but it will not have the same hard, smooth surface as bone. It is better to work from the middle of a long bone toward the ends, so that you start where there is good, solid bone – and follow it out to the poorly preserved ends.

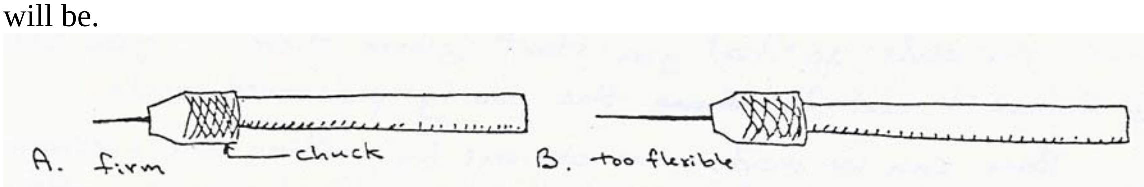
Bone can be made more obvious by wetting the specimen either with water (be careful, the matrix may dissolve or crumble when wet), or with thinner (acetone, methyl ethyl ketone, alcohol), or oil of wintergreen. The latter is available in drugstores, is slow drying, but does dry and can be removed by acetone. The best way to see bone and distinguish it from matrix is to keep your specimen clean - blow off dust frequently.

Chipping, Scratching, Poking

There are some rules to think about when poking at matrix near a fossil bone, but I must admit that I often break my own “rules” and work just however it seems best in a given situation. One rule is to try always to WORK AWAY FROM THE BONE. However, this just isn’t possible when you are removing a crust right on the bone.

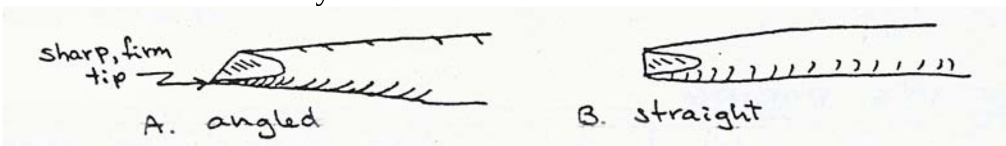


In illustration A, if there is a good “separation” of matrix from bone, the rock will sort of peel off, leaving a clean bone surface. Using a sharp chisel-pointed tool carefully chip down towards the exposed bone, but do not actually hit the bone itself. This chipping can be satisfactorily done with the mechanical hammer or “bipper”, described below. If the matrix does not peel or chip off, try scratching from side to side, as in B. This will dull the tool faster than chipping. A similar motion, with not as much needle wear, is achieved by poking with a needle in a line parallel to the matrix-bone contact, as in C. If you poke, however, you will be more likely to poke the bone, too. Keep that needle sharp! Keeping the needle firm will make it easier to use than a flexible needle. If you use a very fine needle, remember that the less there is sticking out of the needle holder, the more firm it will be.



You may have to have the needle sticking out a fair ways, though, to keep from hitting the fossil with the chuck.

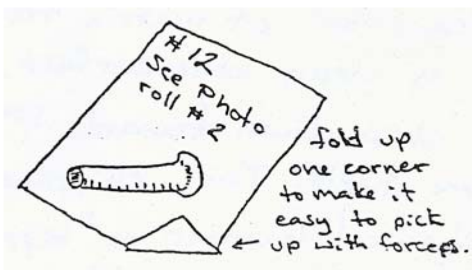
If you are working very close to the bone and the matrix is stubborn, sometimes a chisel-ended needle will allow you better control.



Draw the chisel-end along its sharp edge to "carve" the matrix, or scratch with the tip end (especially with angled chisel end).

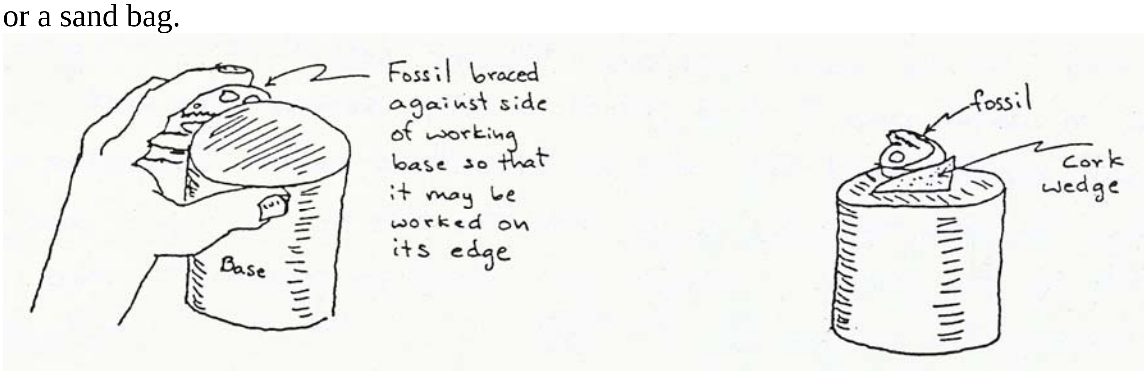
Broken Pieces

If you break off a small piece of your specimen and do not want to glue it back on because it will likely just get broken off again, keep it in a way that it will not get lost and so that you will be able to figure out where it came from. I usually number pieces I have removed and mark the numbers on the piece. If the piece is very small, a good way to keep it is to glue it to a small piece of paper with information written on it.



Holding The Specimen

The specimen should be held firmly but not so as to damage it. It is not always easy to do this as fossils are often of unusual shapes. A wooden block with a paper or cloth pad secured to it works OK as a base, but if you want to twist the specimen and hold it at an odd angle, a flat surface doesn't always work. I brace my work against the upper edge of a base sometimes. Other times I use a base with a sloped surface, such as a wedge of cork or a sand bag.



If the piece you are working on has bone exposed on several or all sides, you must be extra careful. Bone on the bottom may be crushed or broken off and lost if it is pressed hard against a working base while you are scratching at the top.

Try also to be comfortable as you hold your work. Adjust your microscope and working base so you can sit straight while looking through the eye pieces. Rest your arms on something softer that just the edge of the table – I tape a pad to the edges. Any fatigue can be unpleasant and frustrating.

I sometimes imbed a specimen in a protective covering, especially if it is small or delicate. I usually use plaster of paris. Plaster comes as a powder. Here's how I use it: first, I find a small cardboard tray a little larger than my specimen to use as a mold. I line it with plastic wrap – like a piece of bread bag. Then I mix enough plaster to make a solid piece – thicker than the specimen, but not clumsily large. I start with water and add plaster powder to it. Stir and add plaster until the consistency is fairly thick, then pour this in the tray. The specimen should be ready with a protective coating of varnish or plastic and no undercuts exposed on the side to be imbedded. Fill any undercuts with tissue paper. Place a piece of damp tissue paper on the side to be imbedded to act as a separator. This will prevent the fossil from being actually stuck to the plaster. Now gently place the fossil in the wet plaster and push it down as far as you want it. Let it sit an hour or so until it is hard and dry. Plaster sets faster if it is mixed with warm water and if it is stirred a lot. Remove the cardboard mold and plastic and trim the plaster with a knife. Depending on how much the specimen was sunk into the plaster, it may or may not hold in the plaster. When you want to remove it, simply carve away the edges of the plaster until the fossil comes loose.

A layer of latex (liquid rubber) may be used as a "separator" between fossil and plaster. This provides an extra cushion for delicate areas of heavier pieces. Latex may also be used by itself as a cushion, without plaster.

A word of cushion about glued pieces: some glues will become soft and gooey if they are handled a lot or are heated (as with a hot lamp). Beware of this when working with a specimen you have glued pieces onto. Glue will also pick up dirt from your hands. Just be aware of what your fingers are doing to the fossil.

<u>Acid Preparation</u>

Certain specimens are suitable for acid removal of matrix. The matrix must have a high lime (calcium carbonate) content so that it will deteriorate after immersion in acid. If a small piece of matrix bubbles in the acid, then it will probably work. Acetic acid is safest to use, although some people use formic. Both will dissolve bone slowly, so care must be taken to protect exposed surfaces. The usual technique is to submerge the specimen for a short time (an hour or two or maybe even four will be necessary) in dilute acid (about 10-20%), in a glass dish. Then wash it in running water (running slowly) for at least four times the length of time it was in the acid. Next, carefully brush or scrape away the crumbly matrix around the bones where it has clung. A millimeter or two of matrix will be eaten away with each acid bath. The specimen must be thoroughly dried before coating the bone with an acid-resistant plastic coating (such as lucite or elvacite), and the glue must be dry before again submerging in acid. The first drying, to evaporate any excess water, is absolutely necessary or acid may work underneath the protective coating. This drying may be done in a warm oven. But do not warm the specimen to dry the glue-lucite or elvacite – because it may cause the coating to bubble and allow acid to get under it. Pieces of bone that come off, either in the bath or as you mechanically clean the specimen between baths, must be identified, usually by comparing with photographs that are taken before acid immersion. Acid removal of matrix can be carried as far as the specimen will permit.

EQUIPMENT:

Microscope:

A high quality microscope makes a world of difference. With good optics you can work for hours without eye fatigue and see the work far better than with cheaper scopes. I have found the Zeiss fixed-objective stereo microscope to be the best available for this kind of work. This scope allows sufficient working distance or focal length, so that the specimen can be held far enough away from the lens that it can be easily lighted and there is no danger of damaging the objective lens. The stereo zoom Zeiss is more versatile in that the magnification may be changed by turning a dial, but it has less depth of focus and distorts more than the fixed-objective stereo microscope.

Cleaning the Microscope:

Microscope lenses should be kept clean for unimpaired vision. Both eyepieces and objectives can be easily removed for cleaning. If a lens is oily or has gritty dirt or more than just a little dirt, wash it under running water, with soap if necessary. If there is grit on the lens and you wipe it with lens tissue, you are likely to scratch the lens. Dry the lens completely with lens tissue. Do not use toilet paper or facial tissue: these may have grit in them. If you don't have lens tissue, get some – in an emergency, use clean cloth (shirt tail).

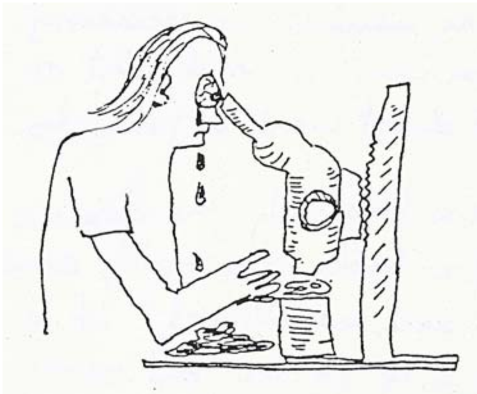
Stereo:

With stereovision we see one object with two eyes, the two images being merged in our brain as one with depth. Many people see mostly with one eye and therefore do not really see in stereo. The stereo microscope allows each eye to see an object from a slightly different angle so that the combined image has depth or is seen in three dimensions ("3-D"). The ability to see depth is a great aid in fossil preparation. [see also the section on photography.]

Lighting:

Microscopic preparation requires good lighting. You will find that you can see your specimen using any old crook-neck table lamp. But your eyes will soon go dim and your hands get hot, so try to get decent lights: I find the high intensity "Tensor" lights work well. One is usually sufficient, though two will give more even lighting. Some microscope lights especially made for this purpose heat up too much making your hands

hot and sometimes softening glue on a specimen. I like the “Tensor” light shade to be at the level of the objective lens so that it is not too close to my hand.
Note: “Tensor” type lights take either 6 volt or 12 volt bulbs. Be sure to use the proper replacement. The 6 volt kind seems brighter.



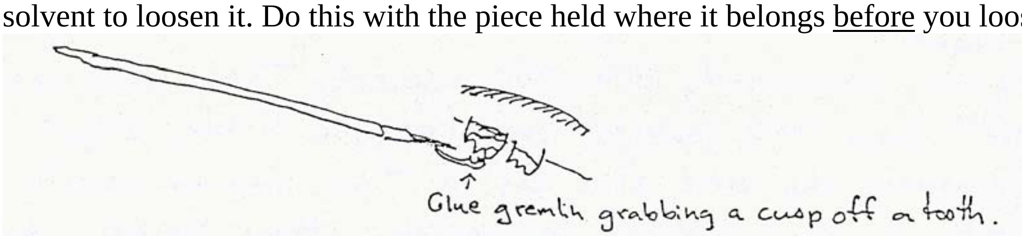
The higher the microscope power you use, the more quickly your eyes will become tired. I find that working for a while with the microscope, looking away for a while, then going back to the scope is beneficial. It is surprising how much clearer things look if you stop a minute and let your eyes rest. Especially do this when you are working on a difficult area. When you come back it will seem much easier.

Glues and Coatings:

Coatings**:**

The usual coating is some kind of plastic in a solvent. The solvent evaporates quickly leaving a thin coating. Ideally this coating penetrates the bone surface somewhat and is tough rather than brittle, but not soft. A wide variety of acrylic resins is available from companies like E.I. Dupont De NeMours (Wilmington, Delaware). From several samples sent to me by Dupont, I found their Elvacite 2044 to be the most satisfactory for general use. It is n-Butyl methacrylate, comes in solid pellets. I usually dissolve it in Methyl Ethyl Ketone ($CH_3COCH_2CH_3$) although acetone works well and may be safer in terms of breathing fumes (both are dangerous to breathe: always avoid breathing fumes of organic solvents!). I use the most volatile solvents, rather than alcohol, say, because they evaporate quickly and allow me to return to work faster. Lucite dissolved in solvent work well (see section on acid preparation). Varnish is sometimes used, but I find it very difficult to remove.

Apply coating carefully and sparingly. Overuse obscures detail. On a small bone that has cracked or where a small piece is loose, touch near the crack or break with a camel/hair brush dipped in thin glue but not actually on it or the broken piece will stick to the brush. If you accidentally stick the broken piece to the brush, use another brush with plain solvent to loosen it. Do this with the piece held where it belongs before you loosen it.



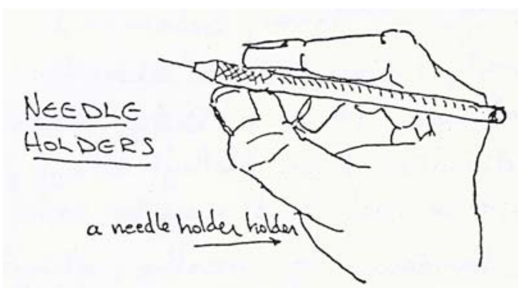
Glues**:**
There are many kinds of glues available. Some are considered permanent, such as epoxy, but are usually unnecessary for small specimens. It is useful, though if you want a solid joint or if you are using solvent on the specimen and don't want a joint to separate.

Of the non-permanent glues there are basically the organic solvent glues and the water soluble glues. The latter are really emulsions of plastic in water – the white glues such as "Elmer's," it is polyvinyl acetate (PVA) in water, takes a long time to dry but never really dries waterproof. It eventually becomes brittle. I find Duco cement to be adequate, though I also use thick solutions of other plastics.

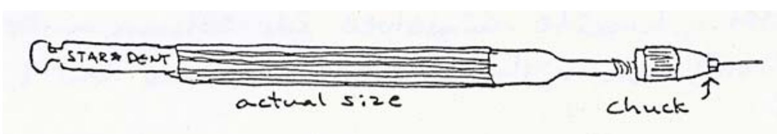
When gluing a specimen use only just enough to hold broken pieces together. Clean off excess before it dries.

Hand Tools*:*

Needle Holders**:**



A needle holder or pin vise is essentially a jacob's chuck with a handle. They are available in many sizes and shapes. Jeweler's supplies places carry a variety (Bartlett and Company, 5 South Wabash, Chicago, Illinois). Hardware stores usually carry the Starrett brand, but there are smaller pin vises that those made by Starrett. I have a small needle holder made by star DENT, but I don't know where I got it. Get one that is comfortable in your hand – you'll be using it a lot. The chuck should be small for small specimens and should hold a needle firmly.

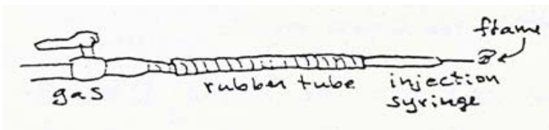


Needles:
Needles must be hard but not brittle. *Sewing needles are OK, but are not very fine steel. A size #12 Sewing needle is quite small, #9 is larger. They must be hardened and tempered for use.

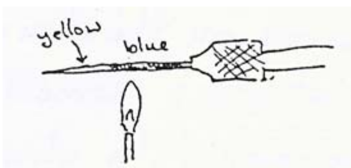
*(U.S. Needle concern (Mrs. Leopold) 1926 N. Kostner Ave., Chicago, 60639)

Fine DRILL BITS are better than sewing needles, but are quite expensive, 30cents-70cents a piece. These are available at industrial suppliers, jewelers suppliers and hobby shops. I use #80 drill bits, nearly the same size as a #12 sewing needle. Some drill bits are OK to use without tempering; Others break when you try to sharpen them and must be tempered.

Tempering And Hardening Needles:
Both hardening and tempering (softening) are done by heating and cooling with a sewing needle you first harden, then temper.

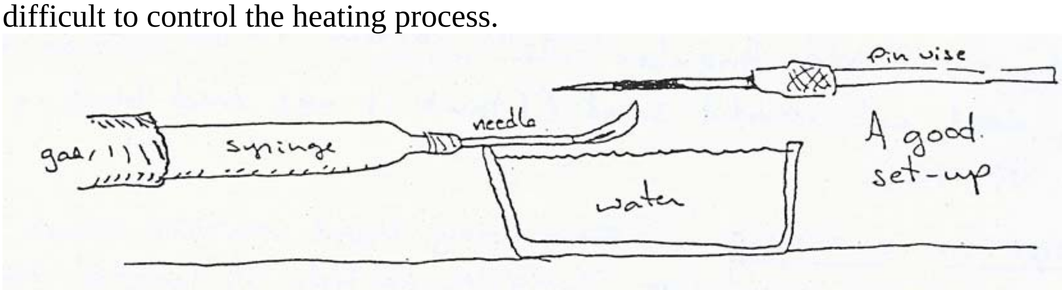


For a small flame I use an old plastic injection syringe without the plunger and with the end cut off. This only works with very low pressure so turn the gas on only a little. To harden, I heat the needle about as hot as I can get the end, so it glows orange. Then immediately plunge it in cold water. It is important to plunge it in fast or the needle will soften. Then I sand the surface darkening off the needle carefully (it is very brittle now) with some #600 silicon carbide paper or fine emory cloth. Then I very carefully hold the needle over the flame so that the point is not in the flame and watch for color to appear. As the needle heats there will be color changes from straw yellow to darker

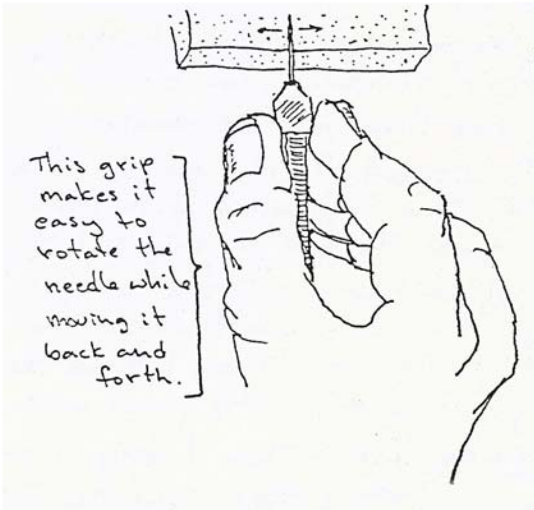


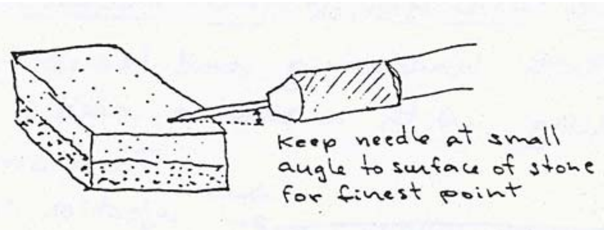
yellow to blue. Straw yellow is what you want the tip to be – that is hard but not too brittle. The darker yellow is softer, blue is quite soft. You must again plunge that needle as fast as you can into water. Then look at it and see where the color stopped. If it got blue all the way to the tip, you will have to go back and harden it.

You may want the tip end very hard. For this, do not temper the point, but do temper behind it. This will prevent the needle from breaking when you sharpen it. The needle should be sticking out of the pin vise as far as possible when tempering or hardening so that the holder will not unnecessarily draw off heat from the needle and make it more difficult to control the heating process.



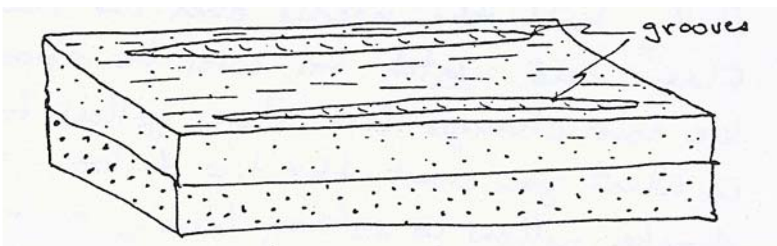
Sharpening:
It is worth repeating: keep your tools sharp! Your needle should look sharp at whatever magnification you are using. For rough sharpening of larger needles, a small motorized circular grinder is handy (see Baehr tool below). But a rectangular sharpening stone with a flat surface is indispensable. I use a Carborundum stone, available in most hardware stores. The 4”x 1 ¾ X 5/8” two sided (fine and coarse grit) stone cost about $2.00.





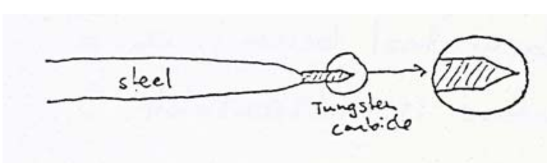
Use a thin oil on the stone, like 3-in-1 or "Bear" oil. To get a round point, rotate the needle evenly while rubbing it back and forth across the stone. For chisel points, hold the needle firmly in one position while rubbing, then rotate and rub in a different position.

I find that my sharpening stone becomes grooved where I rub the needle and these



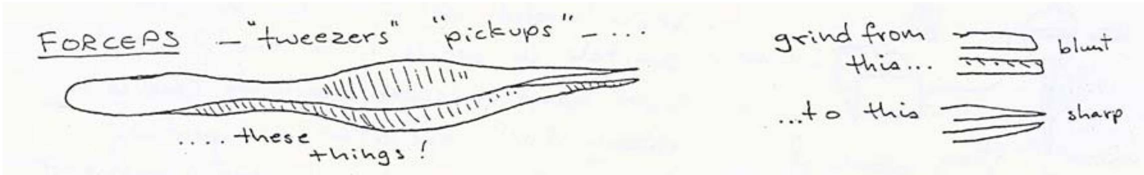
grooves make sharpening difficult. For best sharpening a flat surface is required on the stone. To resurface my stone, I take a piece of flat glass somewhat larger than the stone and grind the stone against the glass with abrasive. Silica sand works fine for this. I use a small amount of sand with water. At first the sand will sort of roll under the stone and there will be a lot of noise. But soon the sand breaks down and produces a paste. Keep replenishing the sand and water as needed. Sand works much faster that five grain aluminum oxide grit. Mostly it is easily available. Angular sand would work faster, I suppose, but I have only used well-rounded sand (I think it was sand-blasting sand – about 1 mm in diameter).

Tungsten Carbide:
For very hard matrix there is no substitute for a harder scratcher. Tungsten carbide is harder that any steel, though it is brittle. Tungsten-carbide tipped scribers are available from industrial or Jeweler's supply companies. The shaft of these tools is steel, usually about 1/8" in diameter with a tip about 1/16" in diameter. It can be easily sharpened on a Carborundum stone. Since Tungsten carbide is brittle, a relatively "blunt-sharp" point is



best, as shown in the drawing. I find this tool to be useful even for quite delicate work. You just have to be especially careful in you are trying to clean out between tiny teeth, say, and the tool won't fit in the narrow space – keep your eyes on where the sides of the tip are rubbing.

Forceps:
Take an old pair of forceps with blunt ends and grind them to fine points for picking up small pieces. No need to buy expensive ones.

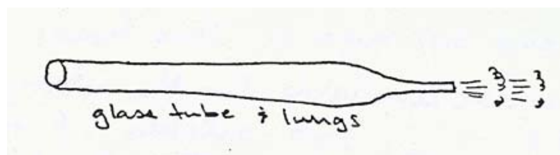


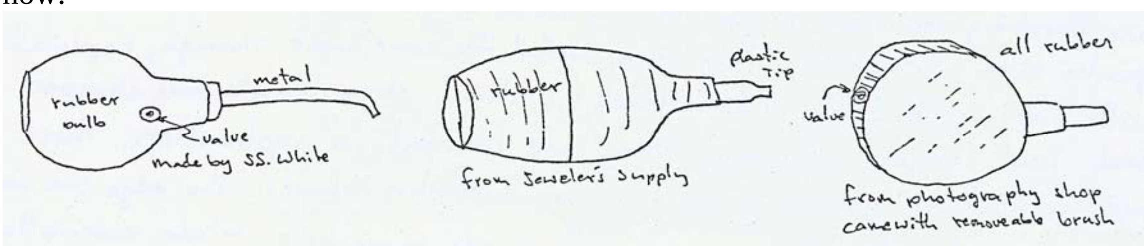
Brushes:
Camel hair artist's brushes (Grumbacher) are expensive, about a dollar a brush, but are worth it. You don't want hairs sticking out poking at things other than what you want to work on (remember the glue gremlin?). Have several sizes, but at least two small ones. I

use a #00 size usually. I use brushes mainly for gluing and coating, but sometimes for removing dust also. With soft matrix and hard bone a stiff brush is sometimes useful. A small wire brush can also be useful, although it will sometimes leave a dark coating of the metal on the bone surface.

Air Blower:

Remember when I said KEEP YOUR SPECIMEN CLEAN? Well, here's how.



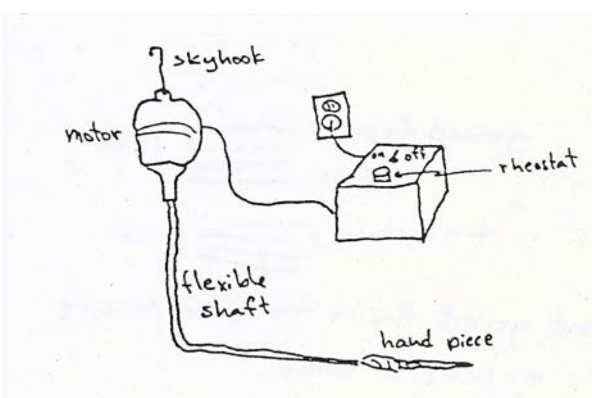


Also can use an ear syringe from drug stores. All of these are simply gadgets to blow a small steam of air onto the specimen. Use it often!

Electric Tools:

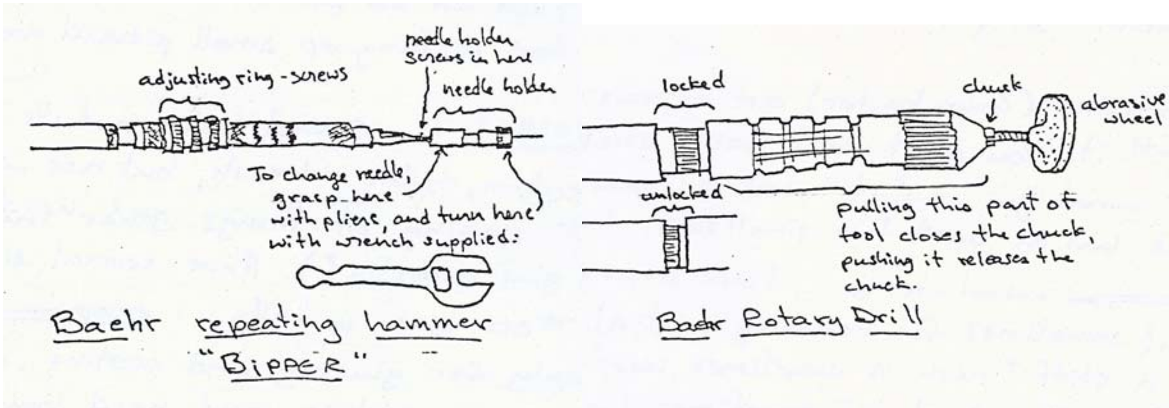
Ernst Baehr Tool "Bipper" & Drill

Although a variety of dentist's drills and other electric motor tolls have been used for



fossil preparation, by far the most useful one I have come across is the Ernst Baehr tool. It consists of a hanging variable speed motor with flexible shaft and interchangeable hand pieces. It comes with a foot-pedal rheostat, but I prefer a hand rheostat, which is easier to maintain a constant speed. I have mine hooked up with an on-off switch in series with the rheostat.

Two hand tools are available. One is a rotary drill, the other a repeating hammer or percussion instrument (sometimes called a "bipper").



<u>The drill hand piece</u>
has a peculiar chuck that is easy to use but takes shafts of one diameter only. Drills are changed by pushing the end of the hand piece in, removing the old drill, placing a new drill in the chuck, then pulling the end out again. This holds the drill securely.

Various metal buhrs are available for the rotary hand piece. These are not especially hard and wear down quickly if the matrix you are working on has silica in it (silica or quartz sand has a hardness greater than most steel). They are useful for some work, though, especially with soft rock (clay or limestone). I think stone wheels are cheaper and last longer, although they are limited in application. These are miniature grinding wheels (see illustration). The edge can be used to cut into matrix. I use this for sharpening points, especially on needles to be used in the "bipper". Sharpening of small needles may be done on this wheel if they are not brittle. But the wheels are usually of coarse abrasive and don't do a fine job.

With any grinding, dust is produced. Matrix dust is not good to breathe, and should be avoided (one can get silicosis). It is possible to hook up a vacuum machine with an outlet (inlet?) near the work so that dust is kept out of the air. If you are working under a microscope the dust problem can be acute. Be sure not to wipe lenses with tissues if there is a possibility of silica dust on them. The silica will scratch the lenses. Wash the lenses under running water first, or at <u>least</u> blow them off.

<u>The "Bipper"</u> – is the hand percussion tool, essentially a miniature jackhammer. Like its large counterpart, the "bipper" can shake things apart, sometimes far from the point of contact. USE WITH CAUTION! If used properly, this tool will take stubborn matrix off quickly (relative to hand-scratching or poking), but you have to use judgement in deciding when to use it. The bipper has a needle holder that screws into it. The needle holder has an adjustable chuck that will hold needles of Victrola needle size [the straight needles used to play old 78rpm records]  or smaller. Phonograph needles are usually used with this, though sewing needles (softer) and sharpened drill bite (harder) can also be used. Phonograph needles need hardening (see under "needles"), and are short: hence they cannot be used for reaching into deep holes. KEEP NEEDLES SHARP! Sharp needles cut better and do less damage, especially when you are near bone. Do not

be deluded into thinking that a dull needle will damage bone less! The blunt point will make a larger hole and be more likely to hit the bone in the first place. Sharpen a dozen points at a time and change them as they dull.

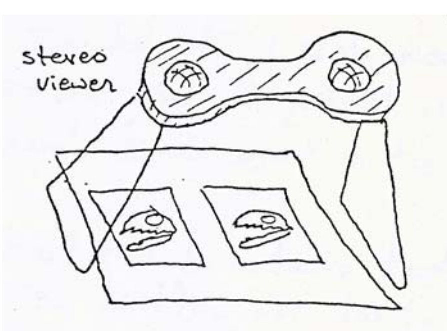
The "bipper" has an adjusting ring that makes it hit harder or softer (see illustration). I usually set it at the softest setting, though individual bippers vary in their adjustments. In using the "bipper", hold it so your fingers regulate how much action it has. This controls the wanted back-and-forth movement and helps to eliminate any unwanted side-to-side movement of the needle. Thus, hold one finger on the needle holder part of the bipper.

Watch that the chuck does not hit the specimen as well as the needle. You won't be able to see the chuck under a microscope, so you must be aware of where it is. Do not push hard with the "bipper". Let it do the work.

PHOTOGRAPHING SPECIMENS:

I take stereo (3-dimensional) pictures of specimens as a record of my progress. I use the black-and-white prints to make notes of pieces lost or intentionally removed. I give removed pieces numbers and for each, show on the photo the location from which it came.

Stereo pictures are simply two different photos each taken from a slightly different angle so as to give the parallax effect that produces a 3-dimensional image in your brain. Thus the two shots are like pictures your two eyes take. Your left eye sees a different picture than your right. The combination of the two gives the stereo effect. Stereo photos are mounted side by side about the same distance apart as your eyes. You focus on the left print with your left eye and on the right print with your right eye. In practice, the two pictures appear to come together until they look like one, except that now, presto! You see depth (kind of like waking up and opening your eyes). This takes some practice to do with your naked eyes. You have to "let" your eyes go apart as though looking at a distant object, but be in focus for close objects. There are stereo viewers that help with this. Keep the prints flat and lined up together properly. There are large viewers for viewing large stereo prints (such as aerial photos). These are used extensively in map making. Geology departments usually have stereo viewing equipment.



Stereo photos can be taken with any camera, with or without a microscope. With a microscope you are limited to the field (or less than the field) and the depth of focus of the microscope. So, unless I need to take a picture of something very small I don't use a microscope. With the microscope you will need an adapter for the camera so you can place it over the eye piece. Take one picture through the left eye piece, the second through the right. NOTE: in determining the proper exposure be sure you are not reading just background light. I use a single lens reflex camera with a behind-the-lens light meter. I usually overexpose one F-stop. This is true of close-ups with just the camera, also. Use a small F-stop for maximum depth of focus. Thus you will want to use bright lights, but for stereo you do not want shadows, so try to use three similar lights. Shadows and reflections on stereo pictures cause “floating” images and confuse the picture. To minimize reflections, the fossil should not be glossy with glue or varnish.

Taking stereo pictures without a microscope, you can move either the camera or the subject to get the 3-D effect. Thus, when I take a picture of a small fossil I put my camera on a tripod mounted pointing down. I take one picture with the object to the left side of the frame, then either move the object or the camera so that in the second picture the object is to the right side. It does not matter which way you move, but it does matter which way you mount the pictures. You will get best results mounting if you do it “by eye”, rather than measuring. That is, look at the stereo pair and bring the two images together with your eyes so you can be sure you have them correctly placed. Use the stereo-viewer if you like. Then fix one to the background with non-glossy tape or other adhesive. Then stereo them again with your eyes and fix the other one. The two pictures should have parallel sides if they were printed correctly.

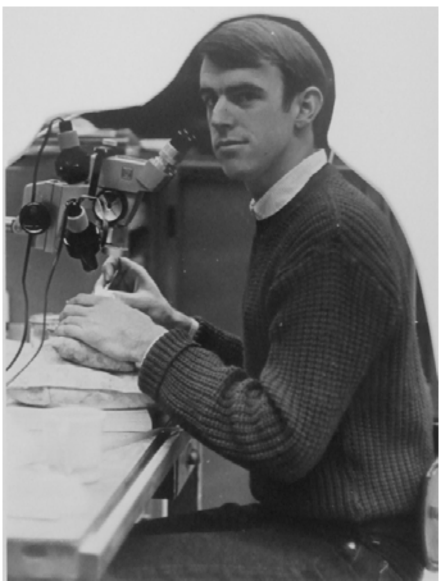
STORAGE OF FOSSILS:

Small delicate fossils should be stored in a place where they will not be damaged. They should be separated from other specimens so that they will not rattle against one another and should be padded in their containers with cotton or other soft substance. A support base may be made as described on page 4. Very small pieces may be stored in transparent vials or glued to small cards. All specimens and pieces should be identified with some kind of description or number so that someone else can determine what they are. A perfectly prepared un-labeled specimen will be a terrible frustration to someone interested in where it came from. It is safest to put numbers directly on the specimen with India ink, but when this is not possible or is undesirable, an identification card should be kept with the fossil.

BIBLIOGRAPHY & AUTHOR INFO:

I first worked with fossils at Ray Alf's museum at the Webb School of California in Claremont. Ray took boys from the school all over the west on weekends and on longer summer trips collecting mainly vertebrate fossils. Back at the school we cleaned bits of jaw with a few teeth or perhaps a complete skull if we had the patience. At that time (I graduated from Webb in 1961) the museum was in the basement of the library. We used pretty basic tools: dental tools, brushes, glue.

I was an undergraduate at Yale University, graduating in 1965. While there I practically lived in the basement of the Peabody Museum. I had a desk in a room full of huge racks full of fossil dinosaur fragments. I made a little pocket money by working on fossils for Elwyn Simons and John Ostrom. After graduating I stayed on for a year preparing fossils for A.W. (Fuzz) Crompton, then director of the museum. It was here that I really learned methods of preparing small vertebrate fossils.



In 1966 I went to the University of Texas, earning a Master's Degree under Wann Langston, Jr. There I also did some fossil preparation, even being a "live" exhibit at the Texas Memorial Museum, preparing and readying for display some larger vertebrates and answering questions of bus loads of school kids.

After finishing at Texas I went to the University of Chicago and spent some time as a student in Evolutionary Biology in the Anatomy Department of the University of Chicago under Jim Hopson, whom I had gotten to know at Yale.

I was not really suited to the role of a scholar, so I went on to other pursuits (I am close to retirement now from my present job as a diesel mechanic at the Port of Portland, Oregon). But I continued working for Jim Hopson on and off preparing fossils until about 1972. Just before I quit that work Jim suggested I write down some tips on preparation, because he knew that he would be having inexperienced students doing the work. So that is how I came to write up the Preparation of Small Vertebrate Fossils.

I always enjoyed working with fossils. There is a lot of satisfaction seeing the teeth or skull appearing slowly out of a chunk of rock. I hope that this paper might help others get the same kind of satisfaction.

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