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Preserving Vertebrate Fossils: Notes From the Laboratory

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Museum Notes

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Preserving Vertebrate Fossils: Notes From the Laboratory

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The word **"paleontology"** is derived from the Greek words meaning "the science or study of ancient life". Usually, paleontology does not concern itself with human remains, artifacts or cultures; these are the realms of archeology and anthropology. Paleontologists excavate and study **fossils**, the remains of once-living plants and animals. By convention, such remains must be at least 10,000 years old to be considered fossils. In North America, there is very little overlap between the sites and materials that are studied by paleontologists and by archeologists because humans are relative newcomers to the continent. A site which produces 11,000 year old mammoth bones, for instance (there are several in Nebraska), is considered very ancient by archeologists but very young by paleontologists. **Vertebrate Paleontology** deals with the remains of the "back-boned" animals such as mammals, birds, reptiles and fish, and, of course, dinosaurs.

The Role of Amateurs

Many paleontologists contend that, due to their overall scarcity and scientific importance, vertebrate fossils should not be collected casually or kept in private collections. But the reality is that if you spend enough time outdoors in Nebraska, regardless of your intended activity, sooner or later you will find a fossil, and the chances are that you will collect it. So, the question is, how can you enjoy fossils and the thrills of discovery without endangering scientific information?

Only about 10% of the fossils in the State Museum's collections were collected and donated by amateurs or the public, but probably more than 50% come from *localities* discovered by them and reported to the Museum. This is a very important distinction because the scientific value of any fossil is determined by information occurring with it ***in-situ*** (in the ground). Other fossils that may be found nearby can tell us about ancient animal communities and climate; the sediments can tell us the age of the deposit, how it was formed and how the fossils accumulated; the positions of the fossils and their relationships to one another can tell us a great deal about ancient stream courses or what may have happened to the bones after the animal's death. Regardless of what we are led to believe by the movies, paleontology is a science built upon the painstaking collection and interpretation of *data*, not simply fossils.

Amateurs can contribute to the scientific process by reporting interesting finds to the Museum and being certain to collect as much data as their expertise allows. From this kind of relationship with the Museum one can learn a great deal more about paleontology, including things probably not found in books on the subject. How much more enjoyable your endeavors would be if you knew you might be helping to solve **the mysteries of the past!**

Figure 1. *A Miocene fossil quarry near Valentine, Nebraska. Several plaster and burlap field jackets cover fossils in the background. Two three-toed horse jaws (center and foreground) are being excavated.*

Figure 2. *Discovery. A paleontologist finds fragments of bone on an outcrop. It might be an elephant jaw! Loose fragments are collected and wrapped, and the locality is documented before excavation begins.*

Figure 3. *Excavation. Careful digging reveals the extent of the fossil. Sediment is removed from around the bones so that the fossil is isolated on a pedestal of rock, but very little of the actual bone is exposed.*

Museums and Collections

Do you know what a museum really is? Yes? Well, there is a good chance that your answer is only partially correct. Few people realize that, in addition to the exhibits and educational programs they see at Morrill Hall, for example, there are vast research collections consisting of thousands of specimens and their documentation. These are *not* fossils "in storage" or "extras". These specimens are being actively studied by scientists from around the world. Such collections are the basis for everything we know about the history of life. Though less visible to the public, research collections fulfill one of the most important roles of the Museum. Properly documented fossils are *never* "extras;" each and every one can tell us something new.

Geology

The surface of the earth is a dynamic place. Oceans invade parts of the continents and then recede; mountains are built by crustal uplift and then destroyed by erosion. But the material that makes up the mountains is not *destroyed* by erosion, it is simply *moved*. For millions of years, sediment from the Rocky Mountains has found its way downslope to the Great Plains, eventually building up deposits of sand, gravel and silt (**sedimentary rock**) hundreds of feet thick. Within these deposits are the fossil remains of the animals and plants that populated the Plains over all those millions of years. As erosion continues its work, now cutting down through these sediments, fossils are exposed at the surface where they may be found and collected.

Each layer of rock is distinctive and can produce quite different fossils. Grain size (boulders, gravel, sand, silt, etc.), composition (quartz, iron, feldspar, calcium carbonate, etc.), color, and structure indicate depositional conditions and help geologists to divide rocks into **formations**. Formations can then be correlated with a **geologic section** to determine relative age. This gives sequence and meaning to the changes we see in animals over time and is very important information to collect with each fossil.

Fossil-bearing rocks in Nebraska can be divided into three general categories by regions. In the east and southeast, limestone, chalk, and shale represent marine sediments deposited in ancient oceans that once covered parts of the mid-continent. In the north, northwest, and southwest, terrestrial sediments deposited on land by streams and wind over the past 35 million years predominate (the "Rocky Mountains" debris). Lying like a blanket over much of central and eastern Nebraska is a layer of "Ice Age" gravels, sands, and silts from 10,000 to 1 million years old.

Occurrence

Vertebrate fossils occur most commonly as scattered individual bones, often broken and abraded before being buried and fossilized. Gravel pits and stream sandbars often produce such finds. Fossils which are found as **float** (loose on the surface, not *in-situ*) are good prospects for the amateur. Recording observations about the rocks in the area and the location of the find are all that is needed to document this kind of fossil, but such a specimen may still be very important. Many kinds of animals are known only from single specimens, and many of those have been found and donated by amateurs!

Occasionally, complete fossil skeletons (such as those at Ashfall Fossil Beds State Historical Park) or extensive bonebeds (Agate Fossil Beds National Monument) may be discovered, but these are exceedingly rare occurrences. A single weathered bone at the surface of the ground may represent all that was ever buried in the sediment in a particular area, or it may just be the "tip of the iceberg" of a significant find. If preliminary examination shows that there may be a complete skeleton or many bones continuing into the rock, they should be left undisturbed and reported to the Museum. Excavation should be left to experienced paleontologists who are trained to collect not only the fossils themselves, but the critical field data that goes with them. Learning how to physically collect a fossil is relatively easy, but learning to recognize the *importance* of a discovery and how to document it takes years of training.

Documentation

Documentation is the single most important aspect of responsible fossil collecting. A well-documented fragment of weathered bone may have far more scientific value than a perfectly preserved fossil skull *without* documentation (a **no-data** specimen).

Figure 4. *Field Jacketing. Exposed bone is covered with damp tissue paper, then strips of burlap are dipped in plaster and smoothed over the top and sides of the pedestal.*

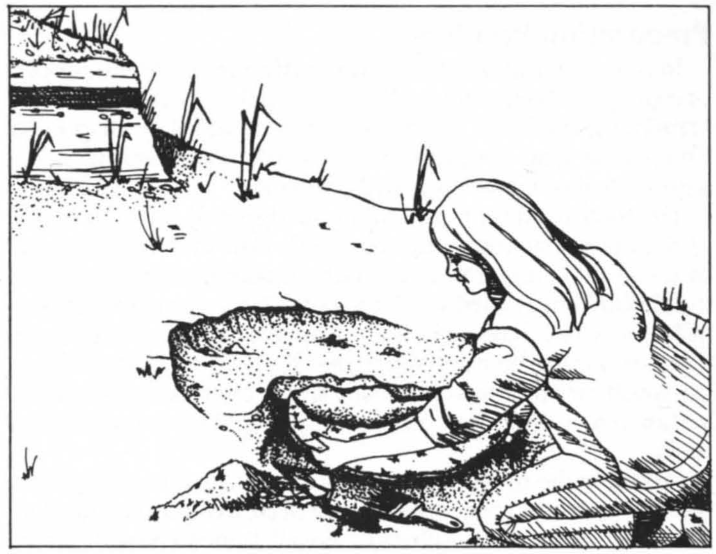

Figure 5. *Removal. After the plaster jacket has hardened, the pedestal is undercut and the jacket carefully rolled over. Additional plaster and burlap may be added to complete the jacket.*

Good documentation of a fossil involves recording in a field notebook, on a map, and on the specimen, various information about its occurrence. This data can be divided up into three general categories: specimen information, geographic location, and geology.

Specimen Data. Each specimen collected should be given a separate number. The number must be written on the specimen with permanent ink and recorded in a field notebook. This number is very important because it links the specimen to all the observations you make about the fossil's occurrence. Also record a brief description of each specimen, the date it is collected, the collector's name, and collecting method.

Geographic Data. All information pertaining to where the fossil was found falls into this category and collectively defines the **locality**. Obvious examples of locality information include such things as the name of the state and county as well as proximity to a highway, lake, or other landmark. Sketching a map of the surrounding terrain, noting features such as windmills, streams, even fence-lines and trees, is an excellent way to document a locality.

The job is made considerably easier by using a special kind of map published by the United States Geological Survey called a **topographic map**. This map shows topography, elevations, many man-made structures, and, very importantly, a system of survey lines that divide the country into townships and sections. You may have seen this system used to define the legal location of a piece of property. This is the preferred way of designating a locality, but if it is beyond your expertise, simply make all the common-sense observations you can to pinpoint your location. A simple compass can be particularly useful in helping to locate your position on a map.

Geologic Data. An outcrop may expose a section of rocks several hundred feet thick and there may be several geological formations (rock units or strata) represented. Exactly where the fossil comes from within this column of rock is very important. The layers of rock represent time, and *when* an animal lived (or died) is critical to our understanding of the sequence of events in the history of life. The best way to record the fossil's **stratigraphic occurrence** is to draw a detailed cross section of the rocks exposed in the area and mark on the drawing the level from which the fossil came. To make an accurate section drawing requires much training in geology. However, a little reading in any of a number of elementary geology texts or popular books will give one enough background to make some useful observations. Weathering profile (does the rock form gentle slopes or vertical ledges?), grain size, color, and bedding ("shaley", cross-bedded, or massive, etc.) are all suitable features to be noted on your section drawing. If formal geologic training is wanting, rely on common-sense observations and descriptions, and well labeled rock or sediment samples. You can measure your section as you draw it using a simple **hand level** to divide the outcrop into eye-height intervals, or a steel tape to measure the thickness of the beds.

Collecting

If the fossil you find is relatively small, sound, and loose on the surface of the outcrop (float), you may be able to simply pick it up, wrap it in tissue paper, and place it in a sack (after you record all the data.) Most vertebrate fossils are far too fragile for this treatment, however. The basic technique for collecting vertebrate fossils, called **field jacketing**, has not changed much in one hundred years. Field jacketing involves making a plaster and burlap cast around the fossil in much the same way a doctor treats a broken limb. The field jacket serves to support and protect the bone so it can be safely collected and transported back to the museum.

Though not a difficult technique, excavating and jacketing a fossil requires several careful steps and may seem confusing at first. The process is illustrated in Figures 2-5, but it is strongly recommended that you observe an experienced collector before trying this yourself. Remember, there is often *no other safe way* to successfully collect a vertebrate fossil.

Sometimes a fossil needs to be treated in the field with **consolidants** (strengthening resins.) Consolidants will be discussed in the next section.

Handy field tools include various paint brushes, trowels, small knives, and rock picks. Necessary supplies for jacketing include burlap, plaster, toilet or tissue paper, water, and a sharp knife or scissors for cutting burlap. Finally, a good permanent marking pen for writing field numbers on jackets, a pencil or permanent ink pen, and the all-important notebook round out the essentials.

Preparation Pointers

In paleontology, the term **preparation** refers to the process of removing the matrix (sediment or rock) from the fossil and stabilizing the fossil so that it can be studied or displayed. The person who does this kind of work (a **preparator**) needs a great deal of experience and patience.

The tools used for matrix removal depend upon the nature of the matrix surrounding the fossil. Soft material like sand or loose silt can be removed with small paint brushes and a dull hobby knife; hard sandstone or siltstone may require carbide pin-vices, hammers and chisels, or small power tools. The fossil must be fully supported by matrix, a plaster/burlap jacket, or sandbags *at all times*, and every precaution should be taken to avoid scratching or chipping the bone with your tools.

Probably the most important but misunderstood aspect of fossil preparation concerns the use of **consolidants** ("hardeners") and **adhesives** (glues). Fossil bones should *not* be sprayed with varnish, clear enamel or any similar material. These simply coat the surface and leave the insides of the fossil fragile and vulnerable to collapse. Museum preparators prefer multiple applications of a dilute, penetrating consolidant that, when dry, stabilizes and strengthens a fossil from the inside out. One part white shellac, diluted with six parts denatured alcohol, was used by museums for many years but has now been largely replaced with modern resins such as "Vinac B-15" and "Butvar B-78" (see resource list.) These newer resins are supplied as beads or powder and are dissolved in acetone at the rate of about 4 ounces per gallon. Consolidants can be applied throughout the preparation process. Matrix that becomes "hardened" accidently can be softened easily with a little acetone or alcohol, then removed. Any solvent-type household glue such as Duco, or thick solutions of Vinac or Butvar may be used as adhesives, but epoxies, "super glues," and white "Elephant" glues should *not* be used. Damp bones should always be allowed to dry before treatment because water prevents consolidants and adhesives from working properly. Be sure to provide adequate ventilation when using these materials and always read and follow all product warnings.

Some Common Questions (and Answers)

Can you tell how old a fossil is by its color or hardness? No. These properties depend upon the kind of sediment the fossil is buried in and the minerals in the ground water. Some bones only a few years old can be dark and mineralized ("petrified") while some fossil bones can appear almost modern.

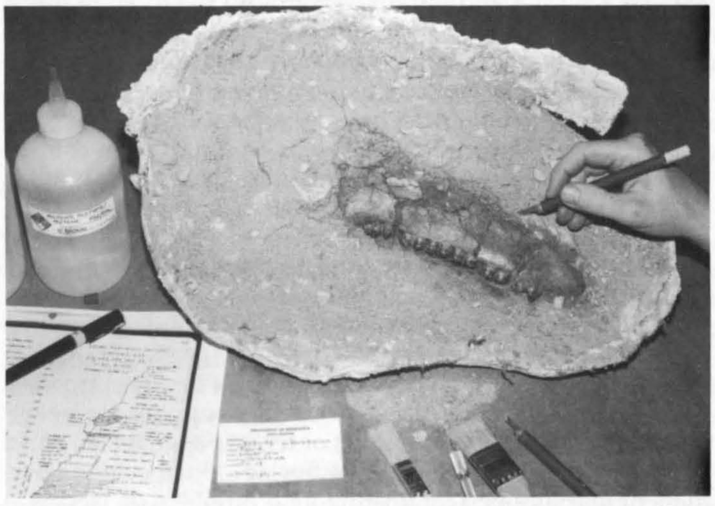

Figure 6. *In the Lab. One of the horse jaws seen in Figure 1, about half way through preparation. Preparation tools, consolidants, tray card, and a copy of the field notes can be seen on the workbench.*

Can a fossil be dated using Carbon-14? Not usually. Carbon dating is accurate only for material up to fifty thousand years old, and many fossil bones do not contain the necessary elements that can be used for dating older materials. These processes are also very expensive. Geologists *have* determined the age of many rock layers, however, so knowing which formation a fossil comes from can also tell us its age.

Do fossils deteriorate when exposed to the air? Not usually. When fossils dry out or are exposed to extremes of heat and cold, they may deteriorate. Exposure to air alone, however, usually does not affect them.

If I report my fossil discovery to the Museum, must I give it to them? No. If your discovery is very important, we hope that you would consider donating it to the Museum, but there is no law that says you must. Museum staff can help you identify the fossil and give you information about how to prepare and preserve it.

Finally...

This article is only an introduction. If you are involved with fossil collecting as a hobby, you have a responsibility to learn all you can about the proper collection, preparation, and documentation of fossils. Please remember that all vertebrate fossils are important, often unique, and always irreplaceable. They are the sole evidence of our prehistory and should be studied and held in trust for all the people.

Resources

Topographic Maps: Conservation and Survey Division, E-113 Nebraska Hall UNL, Lincoln, NE 68588-0517. Request an index sheet of topographic maps, a "how to use" guide, and a list of publications.

Consolidants: Shellac: Local hardware/paint store. Vinac B-15 (polyvinyl acetate): Air Products and Chemicals, 7201 Hamilton Blvd., Allentown, PA 18195. Butvar B-76 (polyvinyl butyral): Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, MO 63167. Consult manufacturers for nearest distributer. Small quantities may be available from Conservation Materials Ltd., 240 Freeport Blvd., Sparks, NV 89431.

Help in identifying or preparing fossils and reporting finds: University of Nebraska State Museum, Division of Vertebrate Paleontology, W-436 Nebraska Hall, UNL, Lincoln, NE 68588-0514. Phone (402) 472-2657.

Additional Reading

Museum Notes, University of Nebraska State Museum, Issues 77 (Fossil Elephant Teeth in Nebraska), 81 (Ashfall Fossil Beds), and 83 (Agate Fossil Beds). Good examples of some of things we can learn from studying fossils and why collecting *data* is so vital.

The Practical Paleontologist by Steve Parker, 1990, Simon and Schuster Press. Probably the best popular introduction to paleontology currently available.

Fossil Animal Remains: Their Preparation and Conservation by A.E. Rixon, 1976, Athlone Press, London. A somewhat dated but good classic text on preparation techniques.

The Cellars of Time, Nebraskaland Magazine, Jan./Feb. 1994, Nebraska Game and Parks Commission. A special issue devoted to paleontology and archeology in Nebraska.

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