PROCEDURES IN COLLECTING FOSSIL VERTEBRATES

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Introduction

The first requirement for the collecting of fossil vertebrates is to know where to look for fossils. The paleontologist usually selects a region for fossil collecting that has exposed sedimentary rocks representing a particular era of earth history. He may identify an area of potential interest by studying the previous geologic and paleontologic literature; but often the published data are inadequate and the paleontologist must begin by field reconnaissance. The fossil collector is much like a detective in search of clues that will enable him to answer such questions as: Where will the remains of fossils be found? In what type of rock will fossil bones be found? Which part of the skeleton are the bones from? What kind of an animal? How to best remove fossil bones from the rock? Therefore, some fundamental knowledge of geology, paleontology, and anatomy is essential to the collecting and interpreting of fossils.

There is nothing magical about finding fossil remains. Paleontological collecting is motivated by scientific curiosity, but a number of other attributes are essential for a successful field season. The fossil collector should have some knowledge of outdoor life and appreciation for nature, and should be able to adapt to living and working in all types of country, and with all kinds of people. Working in foreign lands particularly demands a high degree of adaptability. The collector must make the best of all circumstances and be willing to accept inconvenience and discomforts which cannot be avoided. Looking for fossils involves strenuous activities; each day requires long hikes across rock outcrops in difficult terrain, climbing up and down the sides of arroyos, canyons, bluffs and buttes, digging in quarries , and other forms of physical exertion. The ability to withstand fatigue and the vagaries of weather (especially high temperatures) are essential: good physical conditioning is a must.

Locating Outcrops

The occurrence of fossiliferous outcrops is very unpredictable. The primary sources of information available to the paleontologist are geologic and topographic maps.

Aerial photographs are of two types, verticals and obliques. Vertical photographs show the land surface from directly overhead. Oblique photographs are directed laterally as well as downward. They show the landscape as it might be seen from a high hill or mountain. Because of foreshortening, oblique photographs are less serviceable as maps, but they do show topographic and geologic features more readily to one unskilled in vertical photo interpretation.

Aerial photographs, if they are not taken from too high an altitude, generally are superior to maps for planning paleontological field work in unfamiliar regions. Stereoscopic photographs can be made of both types of aerial photographs. A stereoscopic viewer can be used to analyze adjacent pairs of overlapping photographs. This brings out topographic and geologic features in exaggerated relief because the photographs were taken from points more widely separated than the distance between a person's eyes. The topography, vegetation, and rock outcrops are revealed in great detail.

Although aerial photographs provide a satisfactory photo interpretation of a desired territory, they are not all uniform in scale nor are directions constant or in an undeviating course. Under favorable conditions study of these photographs provides such information as 1) basic rock types and their resistance to weathering and erosion, (e.g., shales are relatively soft and commonly are more deeply eroded than resistant sandstone or other harder strata), 2) geological relationships of different formations and 3) the amount of exposure of the formations.

Where Vertebrate Fossils are Found

For example, the semi-arid Rocky Mountain region of North America contains an enormous sequence of sedimentary rocks deposited in the geologic past and later exposed again through mountain building and erosion. The relative age of these sediments has been established by geological methods. What determines the best area for fossils then depends on the type of exposure. Actively eroding slopes are usually the most promising places to look for fossils. Sedimentary rocks, carved by wind and weather into sloping escarpments, commonly form in the American west a maze of gullies and canyons most appropriately called "Mauvaises Terres", or Badlands, by the early French explorers and settlers; they are bare of vegetation and difficult to cross, whether on horse or on foot. The almost endless expanse of dry, meandering gullies contain little or no vegetation to attract wild or domestic animals. The lack of vegetation and soil cover ensures that fresh rock is constantly being exposed by erosional processes. Today the fossil collector is the only one to gain fruitful fortunes from these bleak but beautiful Badlands.

Base Camp

Once an area is selected, plans are made for setting up a base field camp near the presumed fossiliferous localities. Living quarters vary greatly according to local circumstances. Camping is usually necessary as it may contribute greatly to the efficiency of a field crew in getting to outcrops which are usually situated in remote areas. Difficult country involves the careful selection of equipment and supplies and requires especially sound judgement based on experience; the efficiency, comfort, and even safety of the field party depend upon it.

All field work requires careful planning, both advance planning for an entire project, and procedural planning of day to day activities. The efficiency of field work depends upon using the available time to the best advantage and conserving effort. This is particularly important if the field party consists of several persons whose activities must be coordinated.

Camp life and travel in difficult terrain involves much work that is not related to vertebrate paleontology, and usually must be shared by all; this includes various camp tasks such as cooking, food supplies, water, vehicle maintenance, etc.,. Motor vehicles are, of course, essential for transporting supplies and equipment and also traveling from site to site. Cross-country vehicles which are available today usually have four-wheel drive and make rough, remote terrain accessible. In recent years small airplanes and helicopters have also aided in getting to inaccessible regions, and especially to reconnoitering an area before setting up a base camp.

In camp life particularly, personal idiosyncrasies may become sources of irritation; an even temperament and sense of humor are required to avoid tensions resulting in friction and unpleasantness.

Public Relations

Diplomacy and tact are essential to establish and maintain good relations with landowners and local people. It is imperative that permission be secured to trespass and collect on privately owned land. Very often interested landowners can help the collector by contributing information about the possibilities of fossils in his area. The public lands that are under the jurisdiction of the Federal Government require permits in advance of surveying and collecting from established institutions.

Tools and Equipment

The number and variety of tools depends on the sort of fossils being sought. A fossil collector usually carries a collecting kit hung over one shoulder as he sets out to prospect for fossils. The fossil collector's most useful tool is the Marsh Pick, a light pick (rather like an ice axe) which serves all sorts of purposes from digging specimens to climbing sloping cliffs: one end is pointed while the other end is chisel shaped. In addition, a tool kit typically contains an assortment of chisels, pin vises, hunting knife, various size paint brushes, a whisk broom, dental tools, a small tube of Duco cement (for mending breaks in bones), and a small bottle of thin mixture of acetate glue for strengthening fossil bone. Awls in different shapes and sizes are helpful in uncovering specimens. A curved awl is good for skimming soft rock away from the fossil. The straight awl allows one to probe deeper into the sediment and is used also for scraping the surface of smooth bone. Most fossil collectors' kits have small to large assortment of polyethylene bags that seal shut along the top seam. Tissue paper is essential for wrapping small fragments or delicate bone, and a label can be attached. The following tools cannot normally be carried by a collector, but must be used if a specimen is found which involves a significant amount of excavation: large pick, shovels, plaster of Paris, burlap bags (to be cut into strips for plaster bandages), gasoline operated jack hammer, saw, and sometimes a bulldozer or back hoe for moving large amounts of rock. Even dynamite can be used to remove large amounts of over-burden (sediments that are lying above the fossil site).

METHODS OF COLLECTING AND EXCAVATION

Today, with every kind of sophisticated equipment, the fossil collector must still rely on his professional experience when recovering fossils from the field locality. There are many different ways of collecting fossils, and each is adapted to the requirements of specific situations. However, nothing substitutes for experience in recognizing the different colors, shapes, and textures which characterize fossil teeth and bone and which distinguish it from the associated sediments. For example, some fossil mammal teeth are so small that they would fit quite easily on the head of a pin. The chances seem slim for a collector prospecting for such tiny fossils, even if they were evenly distributed throughout the area. The small size of these specimens may make spotting them exceedingly difficult, and often just a fraction of the specimen is preserved. A slightly different color, a reflection, or an odd texture are among the visual clues which the experienced collector learns to identify as a potential fossil. The fossil collector gives the appearance of a stooped old man, marsh pick at his side, eyes patiently scanning the vast, desolate weathered outcrops for the tantalizing fragments of bone known as "float". Fossil bone is sometimes recognized by being heavier, darker, or multicolored, and tends to crack at right angles to the grain; recent bones tend to splinter parallel to the grain.

The collecting methods employed by vertebrate paleontologists are of several basic types: 1) collecting "float" from the outcrop surface; commonly such fossils have been eroded from their place of deposition and no indication of their original horizon remains (e.g., anthills containing bone fragments collected by ants for building their nest); 2) fossils found in situ, clearly showing exact horizon; 3) multiple specimens found in situ which require quarrying the sediments and collecting the exposed fossils as the rock is broken up; and 4) under water screen washing of fossil-bearing sediments or fissure fill deposits; sediments that contain a low distribution of fossils may be "washed" through a series of screens to concentrate the bones or teeth.

EXCAVATING FOSSILS

When a specimen is located the first step in its collection is the gathering of all surface "float" associated with the find. In doing so, the float fragments are traced up the slope to determine the highest level of the float. If bone fragments are thereby located in situ in the rock, they are carefully uncovered by delimiting the extent of a fossil using small awls and brushes. All over-burden is removed from above the specimen and for a distance on either side of it. A small protective layer of rock matrix is left over the specimen before removing much of the overlying rock.

Because freshly exposed bone is very fragile, the collector applies a mixture of acetate glue to portions that need strengthening. Shellac is not recommended, as it is extremely difficult to remove unless there is absolutely no other substitute available. Sometimes the bones crumble or they are extremely fractured and spongy. It may be necessary to apply large amounts of glue by dripping it on or by brushing (if the bone is not too fragile). Once the specimen is completely uncovered, a coat of glue is applied to the entire fossil and the surrounding rock matrix. Finally, when the specimen is dry and stable, work can begin on trenching around the entire specimen. This procedure leaves the fossil on its rock pedestal that will later allow plaster bandages to be applied to the top and around the specimen. The depth of the trench depends upon how deeply the specimen is buried in the rock. Most specimens usually extend fifteen inches or more below the surface; for safety, the pedestal is made to the depth of two or three times the thickness of the specimen. When working near and around the specimen much care must be taken not to jar the specimen which might suddenly crumble. As soon as the trenching is completed, another coat of glue is applied to the sides of the pedestal. The jacketing technique is generally applied to large and/or fragile specimens.

JACKETING FOSSILS

When the entire specimen and pedestal is thoroughly dry, wet tissue paper is applied to the surface and sides of the block. Medium size brushes dipped into water are used to pat down the layers of tissue paper just prior to jacketing; this provides a separation of the specimen from the plaster when the jacket is later re moved.

Slightly moist burlap.strips, three to five inches wide, are cut long enough to cover the top and both sides of the specimen to the approximate level of bone buried below the surface. It is best to have the burlap strip too long rather than too short. Molding plaster is then mixed to the consistency of thick cream. Hand mixing removes all lumps. One should remember that plaster has a tendency, when mixed rapidly in arid climates, to quickly set-up; alkaline water tends to retart setting plaster. Each burlap strip is dipped in and around the plaster, and then removed. The excess is wiped off with the hands. The strips are then laid over the specimen, and tightly pressed on, around, and under the pedestal to ensure a snug fit. If this step is not properly done serious damage will result to the specimen when it is moved. Each strip overlaps the last by two to three inches. For large or fragile specimens an additional layer can be applied at right angles to the first. Sticks running the full length of the block, attached between the layers, provide added support. If you are fortunate to have a tight fit, then the entire specimen will not slump out as you remove the specimen from its pedestal. The excess matrix is then removed from the bottom, and bandaged in the same way as the top, overlapping the top bandage on both sides. Now the specimen has been completely incased in a protective plaster jacket and can be safely removed to temporary storage at camp.

Smaller fossils of weathered-out fragments of bone or quarry specimens consisting of skull pieces, partial or complete dentitions, single teeth, vertebrae, limb elements, foot bones, ribs and isolated fragments, etc., are all worth collecting and useful for identifying other fossil animals. If not, they can always be discarded back at the Museum after having been scrutinized more closely. Small bones do not require the time consuming process of jacketing. They can often be simply wrapped, labeled, and bagged in a conventional manner after being properly strengthened by glue if needed. Quarried rock containing microvertebrate fossils is split into walnut-sized chunks (or smaller) and examined with a hand lens. Fossil bones may thus be exposed; most frequently the rock will split where there is least resistance, and the fossil is revealed in cross section without excessive damage. In this case, both pieces of the rock should receive a thin coat of glue to hold everything together. Once examined, the fossil then can be wrapped separately, labeled, and placed with other specimens from that quarry. The rock that does not yield any fossils can be put aside for underwater screen washing.

UNDERWATER SCREEN WASHING

This method is useful for small fossils and depends wholly on whether the sediments will break down into unconsolidated matrix when submerged in water. The most important prerequisite is to determine if the fossils will be destroyed if placed in this type of situation. Fossils that do not go to pieces when placed in water, and which are found in sandy, gritty sediments are ideally suited to this technique.

The construction of screen washing boxes described by McKenna (1965). McKenna relates that specimens do go through the screens, sometimes in large numbers. Some consideration must be given to the rate of recovery of specimens and the rate of loss of tiny specimens. Both rates are related to screen mesh size. Matrix should be collected and placed in washing boxes and allowed to soak, thus breaking down. Wet matrix will not expand and break down when soaked, so dry matrix is better to work with. Rapid water flow and varying water level are to be avoided.

After the matrix has been soaked the box should be agitated until no more matrix will pass through the screens, and the residue is then removed and dried. The dry concentrate can either be bagged or put into clean metal sturdy cannisters for shipment back to the Museum.

RECORDING SPECIMEN AND LOCALITY DATA

Each collector should be equipped with field specimen labels to record the necessary locality and identification data for <u>each</u> specimen they collect. Every fossil collection made at one geographical location in one stratigraphic horizon is given locality and specimen numbers before leaving the locality. A popular format for these numbers is as follows:

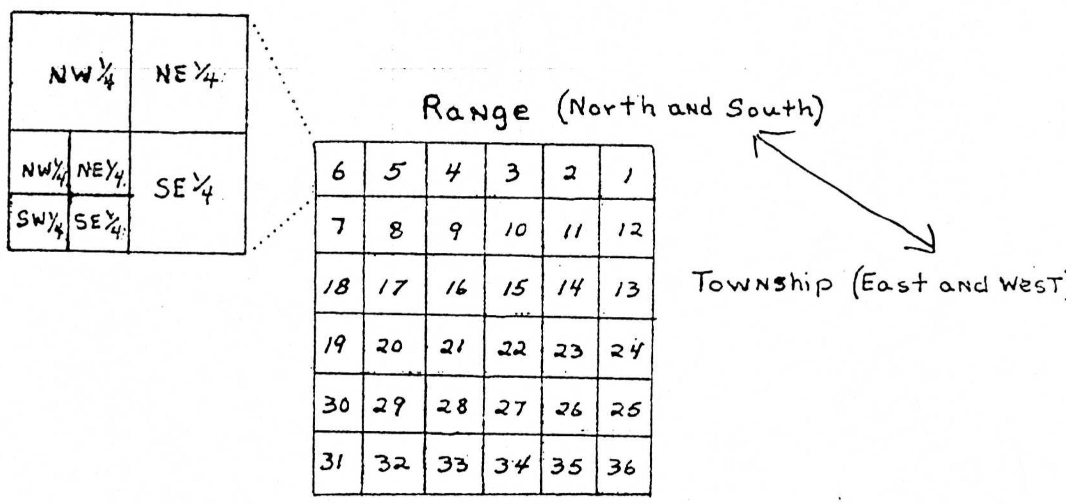
$$75M \frac{7}{40}$$

75M represents the year (1975) in which the specimen was collected in Montana; the fraction represents the 40th specimen from the 7th locality. The location and specimen field number is also marked on aerial photographs or topographical maps.

Most vertebrate paleontologists record day-to-day collection data in a small field notebook. Typical entries would include pertinent information beginning with the data; e.g., a detailed description of the location; an annotated list of all specimens collected there; who collected the specimens and from what horizon and lithology; any Polaroid photographs taken of the locality or specimens, or any quarry sketches. A Brunton compass is useful for recording stratigraphic sections, plotting locality coordinates, and perhaps mapping an area.

LOCALITIES USING PUBLIC LAND SURVEYS

The township, range and section within which a site is located can be read from any recent, large-scale U.S.G.S. Map. On maps of a scale of one inch to the mile (and smaller), section numbers are not given. The sketch below illustrates the standard method of section designation. It is desirable to locate sites more specifically than just the section. This can be achieved by quarter section and quarter-quarter section designation.



CONCLUSIONS

Some of the interesting results of paleontological methods indicate that collecting procedures were basically established quite early, before the turn of the century. Modern paleontologists have refined some of the techniques by more improved materials. The screening, washing, collecting and jacketing methods were used by early paleontologists like David Baldwin, John Bell Hatcher and O. C. Marsh.

It should be emphasized that when collecting fossils much harm could be done if one is unfamiliar with excavation of fossils. Therefore, no one should attempt to excavate fossils unless they are completely prepared with equipment to remove them. It is more important to get in touch with a Museum and get aid or advice from an experienced field collector in vertebrate paleontology. The locality is especially necessary so that one can relocate the site in the future.

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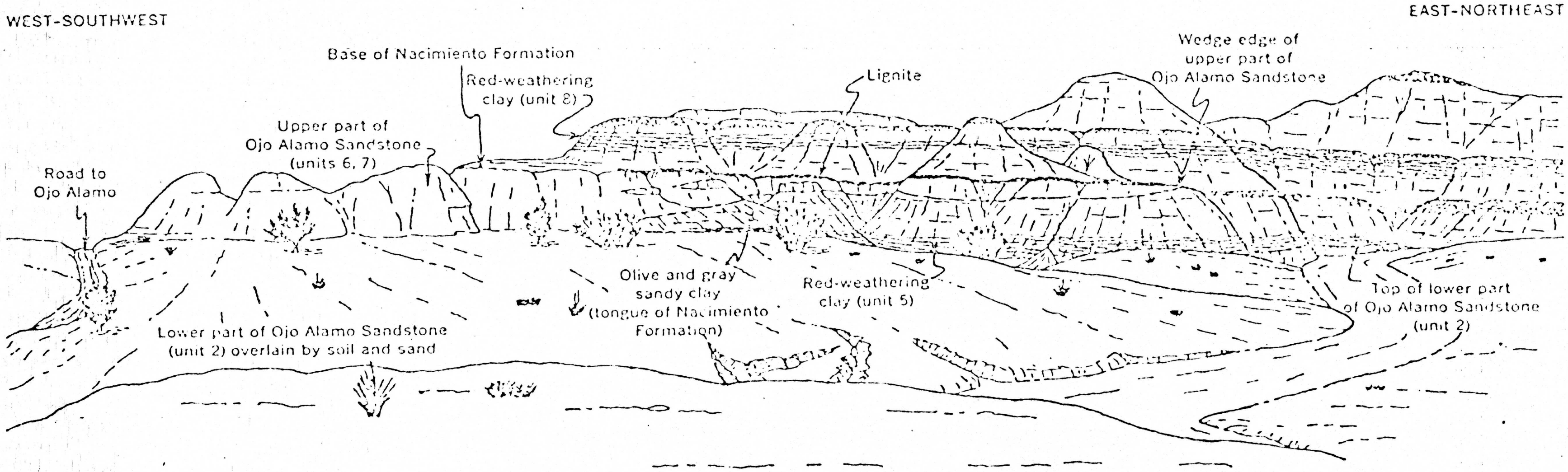
A Sketch or Photograph of the Fossil Site is Important for Recording the Locality.



Steps of Jacketing a Specimen