HANDBOOK OF PALEO-PREPARATION TECHNIQUES

Third Edition

FLORIDA PALEONTOLOGICAL SOCIETY, INC.
FOUNDED 1978

Howard H. Converse, Jr.

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PALEO-PREPARATION

TECHNIQUES

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Howard H. Converse, Jr., Publisher

Florida Museum of Natural History
University of Florida
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U.S.A.

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I am deeply appreciative to the Florida Museum of Natural History for allowing me to use museum records and materials in the preparation of this book. Thanks must also be extended to the Society of Vertebrate Paleontology for allowing preparators to participate with their own sessions during the past several annual meetings and to those preparators who shared their techniques with the group. My especial thanks are due to Rhoda J. Bryant, whose word processing assistance and revised editing put the finishing touches on this work. Finally my thanks to my wife, Regina, for her long patience during the many hours I was away from home.

Howard H. Converse, Jr.

PREFACE TO SECOND EDITION

The *Handbook of Paleo-Preparation Techniques*, when it was published in 1984 by Howard H. Converse, Jr., satisfied a long-standing need in the field of fossil preparation for a technical manual that was comprehensive and, at the same time, clear and concise enough to be used by the professional and amateur alike.

The purpose of this edition remains the same as the first: to provide a manual that deals with the collection, recovery, preparation, restoration, and casting of fossils. It also gives sound advice for setting up a preparation laboratory, as well as a valuable list of materials and suppliers. The first edition, although published in 1984, was written in 1983. In six years, a number of changes have occurred in the fields of paleontology and preparation that the editors feel warrant an update of the first edition. These changes primarily concern the new methods, materials, and tools now being used in paleo-preparation. New casting and molding materials are being introduced to science and industry each year. These new materials normally are not designed specifically for fossil replication; however, their potential for such use is discovered frequently by preparators around the country. Hopefully, a few of these new discoveries will find their way into this second edition.

As with casting materials, paleo-preparation borrows and modifies techniques from many disciplines of science and numerous industries. Heavy liquid separation is one of those borrowed techniques which will be discussed in the second edition. A number of new tools also will be introduced in this edition, such as the Starlite Rotary Grinder and the Airscribe, both pneumatic tools borrowed from industry. In fact, the advantages of a pneumatic-based prep laboratory will be examined.

A few materials and tools will be deleted from the second edition, because time has shown them to be ill-adapted to preparation and casting, especially in the case of tools that have been replaced by newer tools whose effectiveness far exceeds the old.

The bibliography will be expanded and the list of materials and suppliers will be changed to include new tools, materials, and suppliers, and also suppliers whose prices are significantly lower than those in the first edition.

The author of the book, Howard H. Converse, Jr., realized shortly after the first printing, that a revision would be necessary if there was to be a second printing. Indeed, he was working on that revision when he died untimely in the Fall of 1987. Having worked with Mr. Converse for six years and helped with the production of the first edition, I am sure he would approve of the revisions I introduce into this Second Edition of his fine work.

Russell W. McCarty

Chapter 1

INTRODUCTION

In the last several decades many texts and articles describing preparation procedures have appeared, but they completely fail to explain how these procedures are performed. Many of the techniques mentioned in this text are not new, while many others are. Extensive research and development work have been conducted in the Vertebrate Paleo-preparation Laboratory at the Florida Museum of Natural History during the past three years. Major breakthroughs have come about in the realm of casting techniques. The use of silicone rubber filler blocks and light weight plaster bandages used in the manufacture of overmolds has revolutionized the latex and silicone moldmaking techniques. New and less expensive methods of applying top quality silicone compounds have been developed and are covered in detail within this text.

Paleontological research is expanding greatly throughout the country. With this expansion, a shortage of trained paleo-preparators has occurred. It is the purpose of this book to provide an aid to those people wanting to learn the basic skills of the trade. This text is not meant to cover every aspect of preparation and will attempt just the basics needed to safely prepare fossils in one's laboratory.

Preparators often are asked to leave their laboratories and conduct fieldwork at important research sites. This topic is covered lightly and should give an idea of what is to be expected while in the field.

Record keeping is a very important part of any fossil collection. Without accurate detailed data, a specimen loses all of its scientific importance. The Florida Museum of Natural History has allowed me to use all of their paleontological record forms in this text. They show the differences between handwritten records and computer-generated data and an explanation of their use is outlined.

Some museums or institutions are creating scientific displays and exhibits to educate the public in our prehistoric faunal past. An attempt has been made to explain how specimens are restored and reconstructed to make a natural appearing skeleton mount.

Sources for supplies have been very scarce over the years. Institutions locate their most desirable products and continue year after year to procure these items. This information seldom leaves their walls. Only through the visiting scientist are exchanges of new procedures and materials transmitted. The last chapter gives a complete breakdown of supplies and equipment that can be used to set up a preparation laboratory.

The use of actual photographs has been avoided. Simple line drawings are used for a clearer picture of the many procedures.

Chapter 2

THE ROLE OF THE LABORATORY AND THE PREPARATOR

The role of the preparator often begins in the field during recovery of the fossil. The preparator must insure that the specimen suffers no further damage during its transit to the preparation laboratory. This entails making a protective jacket of plaster or any other suitable material, and sometimes performing minor repairs and consolidation on the specimen while it is still in the field. Once in the lab, the preparator begins the task of removing matrix from the fossil and further repairing and consolidating the specimen so that it may be safely added to the collection or placed on display. At times the preparator will be required to model missing portions of a specimen, and even articulate and mount partial or complete skeletons.

In museums and university preparation laboratories, the preparator also will be called on to perform general problem-solving and aid in research by devising new methods, materials, or techniques to solve a particular research problem. Most preparators will be asked to replicate fossil specimens, thus necessitating a thorough knowledge of moldmaking and casting.

The preparation laboratory is the facility that enables preparators to perform their functions. Here will be found all the tools, adhesives, consolidants, chemicals, and lab equipment necessary for completing a job of preparation. Most preparation laboratories also will have equipment and materials to make molds and casts of fossil specimens.

The preparation laboratory must be located in a space separate from the collection storage, designated for the preparation, conservation, and possible exhibit construction of fossil material. It should be adequately equipped to handle all materials involved with its scientific research. It must meet all the needs of the research scientists.

The location of the laboratory is not critical, but should be in the general area of the collection storage (Figure 2-1).

Lighting is very important. With the massive energy cutbacks over the past several years, the lighting in many work areas has been reduced to the minimum tolerable levels. The preparation laboratories must be exempted from this cutback. Good eyesight is demanded and without proper lighting, many tasks may suffer. A good balanced daylight fluorescent system should be considered.

Each worker or preparator should have their own work station; many times this consists of only a small section of a work table. This individual is responsible for keeping track of all his tools and for keeping the work area clean. These work stations should provide comfortable working conditions and, above all, a safe working environment.

An adequate water supply must be present. A large sink with a chemical resistant drain should be furnished. Chemicals, such as acids and solvents, must be periodically disposed of in diluted forms. Water soluble mixtures, ranging from Plaster of Paris, latex, and water soluble plastics (polyvinyl alcohol) frequently are prepared. The sink should be equipped with a sediment trap to prevent clogging because plaster or small amounts of sediments often are washed down the drain.

No preparation laboratory should be without a fume hood. Another item that must be considered along with the fume hood is adequate ventilation. There should always be an adequate air supply coming into the work area so that the toxic hazards from the various chemicals required in the performance of the different preparation operations can be avoided. A large number of resins (epoxy and polyester) gives off fumes that over long periods of exposure can be quite hazardous. All large epoxy or polyester castings must be made outside in an open air situation or within a fume hood when mixed inside the building. All acid removal of matrix is to be performed within this fume hood due to toxic vapors.

Because many of the tools used by the preparator operate pneumatically, it is important to have a source of compressed air. A 2 HP compressor capable of supplying 90-100 psi can be piped to as many as six work stations. Modern preparation tools, such as Airscribe, high-speed rotary grinders, and air-abrasive units, operate on compressed air, and, in general, these air-driven tools are less expensive and have a much longer operational life span due to their simplicity and fewer numbers of moving parts. Compressed air also is used to operate air brushes which are used for painting and latex moldmaking. An air line used solely for blowing dust off specimens and drying is a valuable asset to any preparation lab.

Ample storage space should be provided for the many supplies required to run an efficient laboratory. Plaster of Paris must be stored in an area capable of handling very heavy loads. At approximately 100 pounds per bag, this load can build up fairly fast. Other consumables, such as latex, cheesecloth, and various chemicals, should be stored in upright steel cabinets within the laboratory or a short distance from the laboratory for easy access. Silicones, when purchased in large quantities, should be refrigerated to extend the shelf life of the compounds. A standard home-size refrigerator should be present. Shelving should be available in adjacent rooms or within a major storage area to house the many field supplies and plaster jackets brought in after a field season. These shelves should not be in the preparation laboratory.

The chief preparator of most large preparation laboratories must perform many tasks other than just preparing fossils. This individual is charged with the job of overseeing all aspects of the laboratory operations. These duties can range from maintaining aud ordering all of the necessary equipment and supplies for both the laboratory and field work, handling all technical correspondence, properly overseeing the flow of specimens coming into and leaving the laboratory, assigning the work to other members of the staff, and supervising all of their work to insure the highest efficiency output. The individual in such a position should have an office separate from the laboratory to be able to conduct these many tasks. A continual check must be made to insure that overloading of the laboratory with excess work does not occur and that the laboratory is kept relatively clean at all times.

As a preparator, many disciplines must be mastered. An individual must have a knowledge of anatomy and chemistry, be part artist, and be capable of working with a variety of materials from metals to plastics. Each individual working in a preparation laboratory must be aware of their limitations. When in doubt about a procedure or a problem in preparing a specimen, this individual should consult an expert or search the literature for a possible solution. It could be harmful to the individual and the fossil if one attempts to work beyond their limitations.

Safety in the preparation laboratory should be the first order of business. Given the nature of the tools and chemicals used in the lab, common sense rules of safety must be followed always.

When working with hammers and chisels or mechanical devices that remove matrix, protective goggles should be used to protect the preparator's eyes. Also, it is wise to wear goggles when using acids, bases, or any other chemicals that may cause eye damage.

Many tools in the preparation lab generate high noise levels that can, with long term use, damage hearing. It is wise to have a good supply of ear plugs or, better yet, the head-phone style sound mufflers. Certain aspects of preparation generate large amounts of dust which can be harmful if breathed. Air abrasive units, even with dust collectors, produce airborne particulates that can cause silicosis of the lungs if dust effective respirators are not worn. Dust of any kind can be harmful if breathed in large quantities. It is not unusual for the preparator in older museums to encounter specimens containing asbestos in the filler material used for repairs. Asbestos was used widely in preparation until about 1970. When preparing or grinding out filler material from older specimens, it is wise to wear a respirator.

Solvents, adhesives, epoxy casting resins, and heavy liquid separation chemicals are only a few of the many chemicals that produce harmful vapors. Chemical respirators must be used when dealing with such compounds. A dust respirator will **not** filter out harmful vapors. Although the preparator may be protected by a mask, other personnel in close proximity may be affected. If the air handling system of the preparation lab is directly connected to other rooms or to a central system, it is advisable to perform certain operations outside the building or in a rated fume hood. Most manufacturers will, on demand, supply the purchaser with a Material Safety Data Sheet (MSDS) which details the hazards of the chemical or compound purchased.

Because chemical spills are always possible, it is advisable to have on hand kitty litter or an approved chemical absorbent. Disposable diapers can be used for small spills. Eye wash stations and chemical showers, if not in the preparation lab, should be close enough to be easily accessible should an emergency occur.

Solvents and other chemicals used in the preparation lab are flammable. Care must be taken when using them. Safety cans are advisable for storing such liquids, and flame proof chemical cabinets should be used if possible to store all flammable chemicals. Fire extinguishers should be strategically located and their locations made known to all persons using the preparation laboratory.

Safety is common sense. **Do not** take unnecessary risks or expose others to risks. **Do** take a little more time--use your goggles, or ear plugs, or the proper respirator for the job.

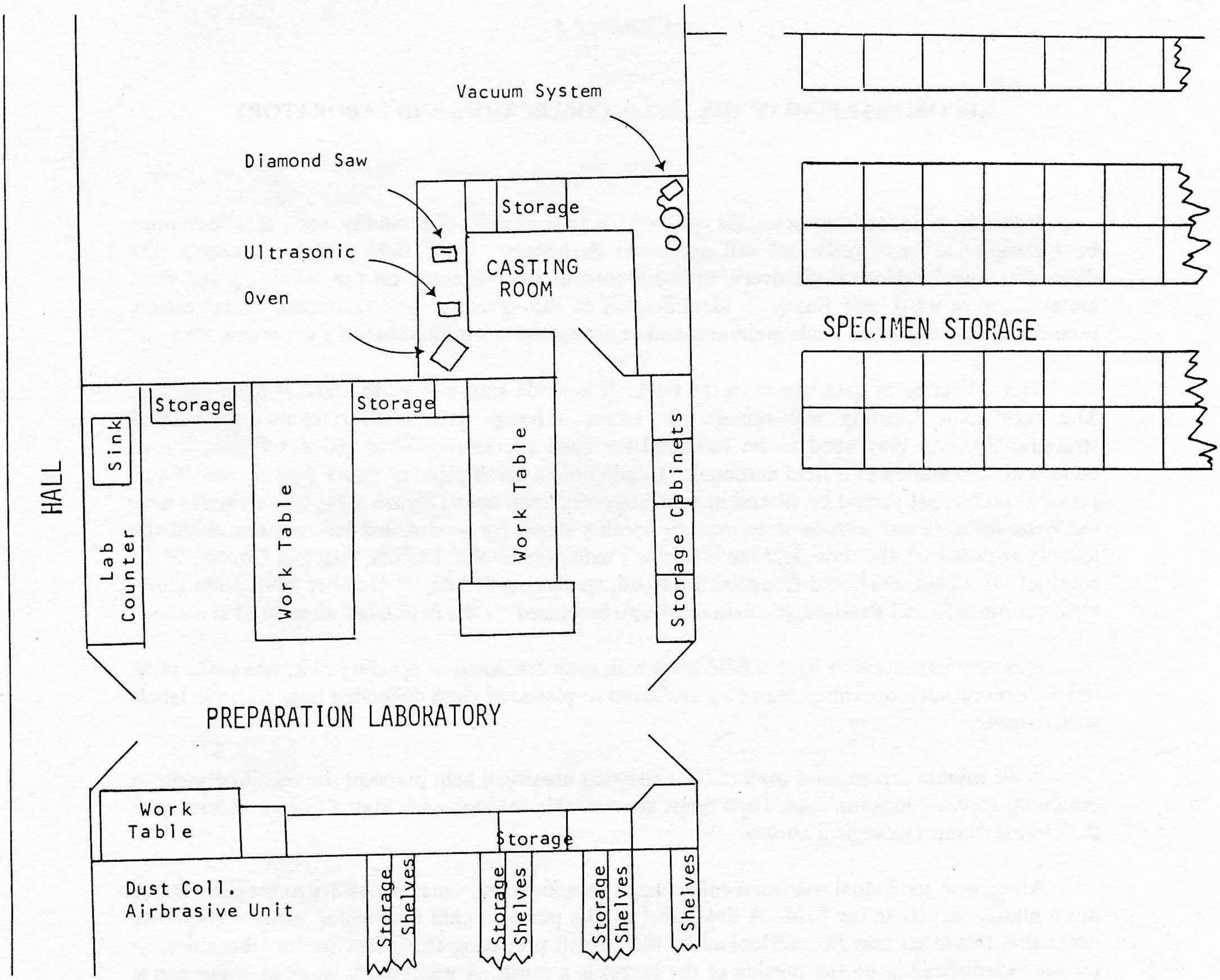

FIGURE 2-1. A basic floor plan of the vertebrate fossil preparation laboratory showing relationship to main collection and storage areas at the Florida Museum of Natural History.

Chapter 3

RECORD KEEPING IN THE FIELD, COLLECTION, AND LABORATORY

If fossils, or indeed any scientific collection is to have scientific validity, each specimen must be accompanied by records that will document its history. From field data that describe the discoverer and location of discovery, to the record of repairs made on the specimen and what materials were used, and finally to identification of the specimen and taxonomic classification, record keeping of various kinds maintains and enhances the scientific value of a specimen.

The collecting of data begins in the field. It is made simple if all material is from one site. The geographic location will remain the same, although grid measurements and vertical stratigraphic level may need to be recorded for each specimen. Most paleontologists record collecting information in a field notebook. In addition, a small piece of paper (waterproof ledger paper is preferred) should be placed in each collecting container (Figure 3-1). Each should have the basic information such as state, county, locality name (or as detailed information about the locality as possible), the date, and the collector's name (example: Florida, Alachua County, 10 mi south of US 441 on Seaboard Coastline Railroad, spoils near trestle, 24 October 1981, John Doe). Grid coordinates and stratigraphic data must also be placed on the field label when used at a site.

It is very important to have a field label with each specimen or specimen lot, when one visits more than one site. Specimens can be transferred to plastic or cloth collecting bags with the labels sealed inside.

A 7½ minute topographic map of the collecting areas will help pinpoint the sites and assist in obtaining accurate location data. Topo maps are available through each State Geological Survey or the United States Geological Survey.

Along with individual specimen collecting, it sometimes becomes necessary to prepare one or more plaster jackets in the field. A field label can be placed within the plaster jacket. There are times that this label may be overlooked by the person preparing the jacket in the laboratory, so external identification on the outside of the jacket is a must. A waterproof black marking pen is needed for this operation. Red ink and pencils fade and are not recommended. Record all scientific data possible on the outside of the jacket. A simple sketch showing the bone location within the jacket should be outlined along with this data (Figure 3-1). This preserves the location on the outside of the jackets and provides an instant reference to the sites while the jackets are stored on shelves prior to preparation.

The specimens and plaster jackets are brought into the collection and stored with the field labels until each has been properly cleaned and preserved. Many collections maintain an accession file to record how each lot of specimens reaches the museum. At the Florida Museum of Natural History an accession record system is used at this point only if the specimens are contributed by non-museum personnel. The museum then acknowledges the collector, source, and locality. This serves as a record of the contribution. The field tag information is transferred to a catalogue, which consists of a ledger-type book or a numerical card file and lists each specimen that is worth keeping (Figure 3-2). This file should contain the specimen number, identification of specimen (name), complete locality data, nature of specimen (tooth, vertebra, partial mandible, etc.), collector's name, date collected, and any other data that is important to the specimen. If the identification is unknown, it is not critical; some descriptive phrase ("flat brown fish [?] tooth") would do just as well until proper identification can be obtained.

The catalogue becomes a permanent record and part of the collection itself. The catalogue number recorded in the catalogue ledger or card file must be written on or attached to the specimen. This is the important link from the specimen to the catalogue. Other information, often abbreviated, may also be written on the specimen. A dark specimen must have a small stripe of flat white enamel painted on a spot that will not cover up diagnostic characters (e.g. along the side of a tooth or a long bone, etc.; Converse, 1976). The number can be written directly on the specimen if the bone is light in color (Figure 3-3). The ink used in numbering the fossils should be a waterproof black-carbon writing ink, which can be used in most fountain pens. A fine-pointed drawing pen is preferred and is available at most office or art supply stores. One coat of hardener such as Butvar B-76 or a thinned Duco cement should be placed over the catalogue number. This helps prevent the identity from being rubbed off during handling.

An individual specimen label should be prepared and placed with each specimen stored in a collection. The specimen label should be small, but usually should convey all of the information found in the catalogue record (Figure 3-4). The label is kept with the fossil at all times.

Computers are currently revolutionizing the scientific world. Programs are now available that can create a specimen catalogue and are capable of holding more precise, detailed data than can be written in ledgers. Data in any form can be recalled from these catalogues. Data regarding all the specimens from one site or locality can be grouped together and a printout received. One can retrieve printout lists of all fossils of a certain species or from a particular region from the catalogue in a very short period of time. With conventional handwritten catalogues, it would take many man-hours to perform this task. The entire process of entering and documenting specimen data is greatly speeded up.

Another great time saver that can be generated through the computer catalogue is the specimen label. Small enough type is available to print labels with much more data than found on handwritten forms and with much less effort.

The computer will not totally replace the human element of record keeping. Records must still be compiled, processed, and proofed, but the computer allows more time for specimen preparation by the individual.

Specimens occasionally have to be removed from collections for purposes at one's own institution or as loans to other individuals or institutions. A small label should be placed in the storage box or cabinet showing the withdrawal of the specimen (Figure 3-4), including its disposition, and should be removed once the specimen is returned to the collection. This record aids in accountability and inventory control of a collection.

Another important record for outgoing specimens is the loan invoice or shipping invoice (Figure 3-5). This form gives a complete record of transactions and also acts as a signed receipt for the material. The invoice should be used even for intra- and interdepartmental loans and transfers. Accountability of large collections would be impossible to maintain without this invoice record.

Specimens being routed from collections or the field into a preparation laboratory should have a "Work Request" form filled out and processed through the laboratory (Figure 3-6) (Rixon, 1976). This form is a necessity in maintaining a laboratory record of specimen processing and the techniques employed during preparation or casting. It covers all types of work entering the laboratory. The form is filled out in detail when a scientist requires a specimen to be prepared or cast and is sent with the specimen into the preparation laboratory. The preparator, or whoever is assigned to the work, receives the card and keeps it with the specimen until the job is completed. A record is placed on the back of the card showing all treatment the specimen has received, the date on which the work was started, and to whom and the date it was returned.

In controlling the flow of jobs into the preparation laboratory, this system has an advantage. Should the specimen ever be processed back into the laboratory, the card can be retrieved from the files and checked to see what previous treatment was performed. This record provides useful information on the longevity of consolidants or adhesives and, should it ever become necessary to remove any filler material, the preparator knows what material to deal with.

Progress reports can be processed at year's end from the data generated by this file. The volume and the type of work performed are readily available.

REFERENCES

Converse, H.H. 1976. Techniques in paleontology. The Plaster Jacket 26:1-18.

Rixon, A.E. 1976. Fossil animal remains--their preparation and conservation. The Athlore Press, London. 304 pp.

FLORIDA STATE MUSEUM
UNIVERSITY OF FLORIDA
VERTEBRATE PALEONTOLOGY

LOCALITY:

COUNTY: .... STATE: ....
MAP NAME: .... SEC. .... T. .... R. ....
COLLECTOR(S)

DATE:

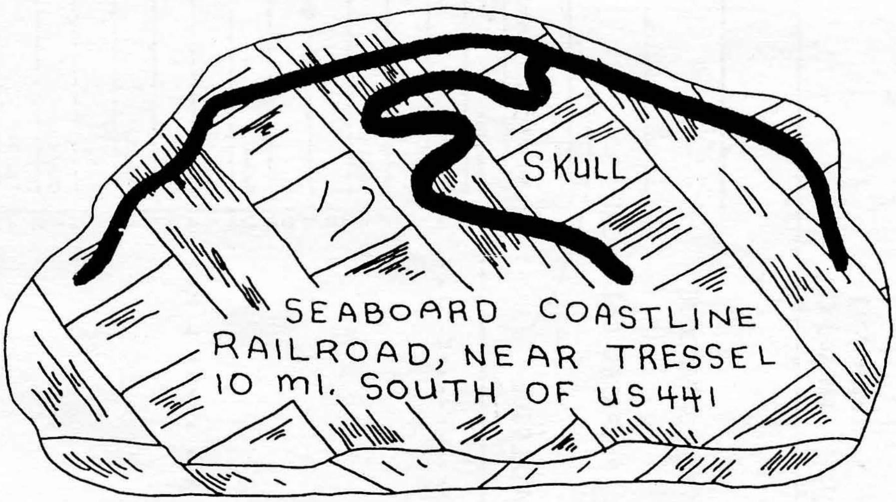

FIGURE 3-1. Top, sample field label. Bottom, external identification markings required on a plaster jacket showing locality data and specimen orientation and identity.

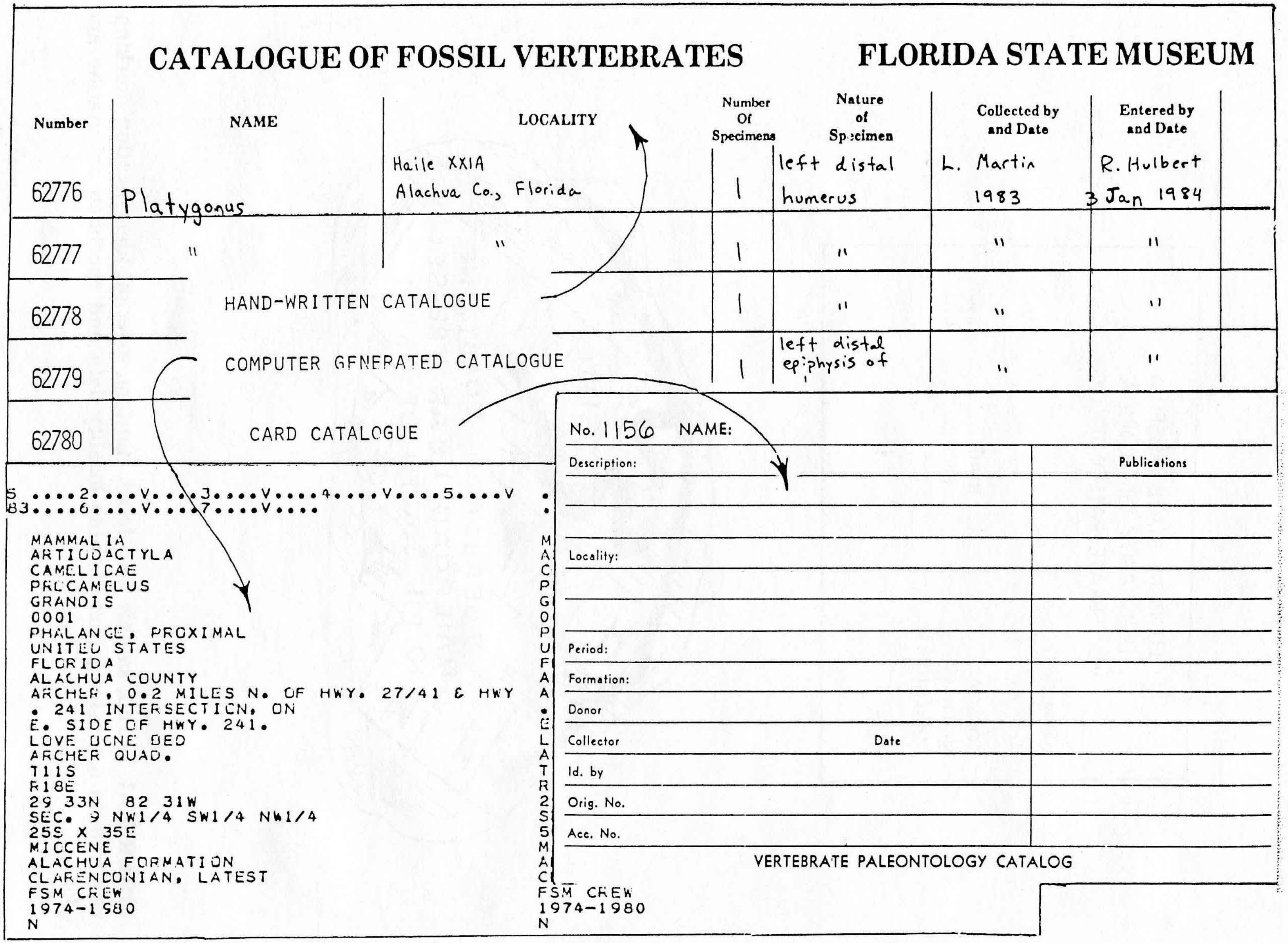
CATALOGUE OF FOSSIL VERTEBRATES
FLORIDA STATE MUSEUM
Number
NAME
LOCALITY
Number Of Specimens
Nature of Specimen
Collected by and Date
Entered by and Date
62776
Platygonus
Haile XXIA
Alachua Co., Florida
1
left distal humerus
L. Martin 1983
R. Hulbert 3 Jan 1984
62777
62778
62779
left distal epiphysis of
62780
HAND-WRITTEN CATALOGUE
COMPUTER GENERATED CATALOGUE
CARD CATALOGUE
MAMMALIA
ARTIODACTYLA
CAMELIDAE
PROCAMELUS
GRANDIS
0001
PHALANGE, PROXIMAL
UNITED STATES
FLORIDA
ALACHUA COUNTY
ARCHER, 0.2 MILES N. OF HWY. 27/41 & HWY
. 241 INTERSECTION, ON
E. SIDE OF HWY. 241.
LOVE BONE BED
ARCHER QUAD.
T11S
R18E
29 33N 82 31W
SEC. 9 NW1/4 SW1/4 NW1/4
25S X 35E
MIOCENE
ALACHUA FORMATION
CLARENDONIAN, LATEST
FSM CREW
1974-1980
N
No. 1156 NAME:
Description:
Publications
Locality:
Period:
Formation:
Donor
Collector
Date
Id. by
Orig. No.
Acc. No.
VERTEBRATE PALEONTOLOGY CATALOG

FIGURE 3-2

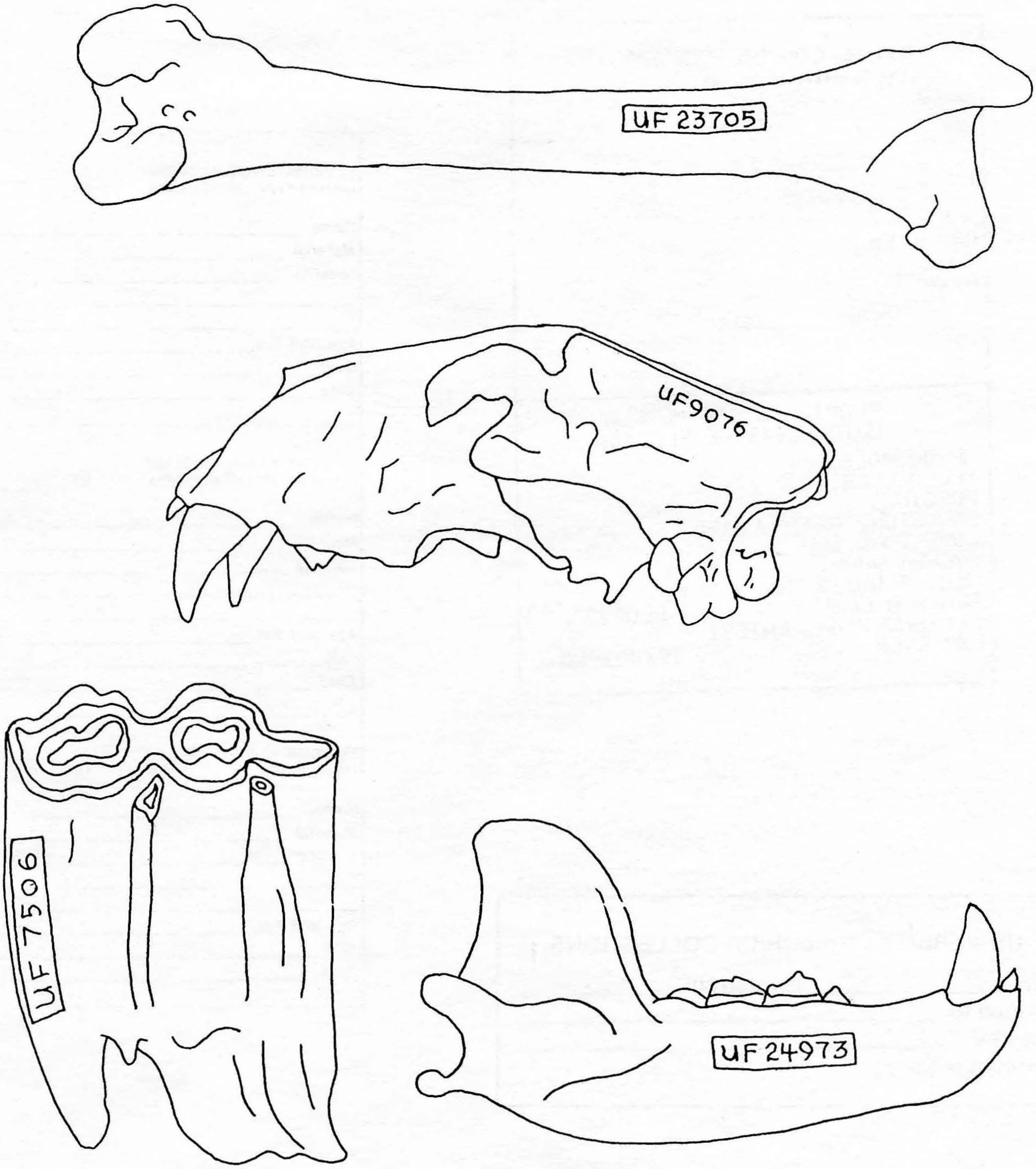

FIGURE 3-3. Typical catalogue numbers properly located on specimens. Numbers in boxes are on white painted strips on dark bone backgrounds.

FLORIDA GEOLOGICAL SURVEY
FLORIDA STATE MUSEUM
UF/V

Name
Mat.
Loc.

Age & Fm
Coll
Date

FLORIDA STATE MUSEUM
UNIVERSITY OF FLORIDA
UF 00040253
TELEOCERAS
FOSSIGER
SKELETON, ARTICULATED
LOVE BONE BED
ARCHER QUAD. T11S R18E
SEC. 9 NW1/4 SW1/4 NW1/4
ALACHUA COUNTY FLORIDA
CLARENDONIAN, LATEST
FSM CREW 1974-1980

FLORIDA STATE MUSEUM
UNIVERSITY OF FLORIDA UF________
Name ________
Material ________
Locality ________
Age and Fm.________
Coll.________
Date________

FLORIDA STATE MUSEUM
UNIVERSITY OF FLORIDA UF________
Name ________
Material ________
Locality ________
Age and Fm.________
Coll.________
Date________

FLORIDA STATE MUSEUM
UNIVERSITY OF FLORIDA UF________
Name ________
Material ________
Locality ________
Age and Fm.________
Coll.________
Date________

UNIVERSITY OF FLORIDA COLLECTIONS
Date ________ Invoice No. ________
On loan to ________
Species ________
Catalogue No.

FIGURE 3-4. **Top left, computer-generated specimen labels. Bottom left, specimen withdrawal form. Right, strip specimen labels printed for use in a typewriter.**

WORK REQUEST **VERTEBRATE PREPARATION LAB**

Specimen No.	Field No.	Work Requested By	Date	Date Needed

Name of Specimen	Treatment Required
	☐ General Prep ☐ Other (Describe)
	☐ Hardening
Description	☐ Repair
	☐ Casting
	☐ Mounting
Location of Material	Special Instructions
Return to	
☐ (Person)	
☐ Collections	
☐ Will Pick Up	
	FSM-VP/01-84

PREPARATION RECORD **(LAB USE ONLY)**

Specimen No.	Field No.	Assigned to	Date	Date Completed

Condition on receipt	Consolidants	☐ B-15
		☐ Glyptal
		☐ B-76
	Adhesives	☐ Duco
		☐ Epoxy
Preparator's Comments		☐ B-15
		☐ Glyptal
		☐ B-76
	Reinforcement	☐
	Filler	☐
		☐
	Mold	☐ Latex
Initials		☐ Silastic
		☐
Final Disposition	Cast	☐ Plaster
☐ Picked up by		☐ Epoxy
☐ Returned to		☐ Fiberglass
☐ Collections		☐
☐ Other		

FIGURE 3-5. Request for Work Card. Top, front of card; bottom, back of card.

FLORIDA STATE MUSEUM
University of Florida
Gainesville, Florida
32611
SHIPPING INVOICE

Page ☐ of ☐

14

Correspondence should be addressed to

____

Our invoice number______________________ Your invoice number______________________

TO:______________________
DEPARTMENT
____
INSTITUTION
____

Attention:______________________

The items listed are sent as:

- ☐ a gift
- ☐ an exchange
- ☐ a loan at your request
- ☐ materials to be examined at our request
- ☐ a return of materials loaned to us
- ☐ a return of materials sent for identification
- ☐ ______________________

Date shipped______________________

Method of shipment______________________

☐ Collect ☐ Prepaid

Insured for . . . . $______________________

Number of packages in shipment______________________

Packed and checked by______________________

Authorized and approved by______________________

The prefix UF/FSM should be used in citing these specimens in publication.

Nature of materials and total number of items:

Catalog No.	Identification

All of the above items were RECEIVED in good condition except as noted.

______________________ NAME ______________________ DATE

All of the above items were RETURNED in good condition except as noted.

______________________ NAME ______________________ DATE

CONSIGNEE: Loans are made for six months. Please request an extension if materials must be kept longer. Receipt is acknowledged by signing and returning one copy of the invoice; a second copy is for your files.

130812

FIGURE 3-6. Sample of the Museum's shipping invoice.

Chapter 4

FIELD COLLECTING TECHNIQUES

It is important to remember that before entering a collecting area, be it private or public, the collector must obtain permission. Most states, as well as the federal government, have passed laws to protect their fossil resources and require the collector to have a permit before collecting on public lands. Many privately owned fossil collecting areas have been closed to collectors because of littering and other abuses. Privately owned mines and quarries, which are often rich in fossils, usually have "NO TRESPASSING" signs posted for the protection of the owner and the collector. Cave-ins, drownings, quicksand entrapment, and snakebite are but a few of the hazardd found in mines and quarries. If the land is posted, you can be taken to court for trespassing. **Get permission first!**

Because of the great variety of physical environments in which fossils occur and the resulting field conditions, this chapter can only cover basic field techniques and highlight those procedures that are common to most field situations. Every state in this country has areas in which fossils may be found, and each of these areas will present unique problems, not only in collection methods, but also in field preservation techniques. This chapter will introduce methods and materials, but common sense will have to be the collector's guide.

Spoil Bank Collecting

Most mining and dredging operations have overburden spoil banks. Fossil remains can be found in many of these spoils, especially after they have had time to weather. Complete specimens are found very rarely, as skulls or large bones usually break when the overburden is dumped onto the large spoil mounds. Even so, important finds can be made at such sites, if the collector is diligent (Figure 4-1).

Beach collecting is very similar to spoil collecting. Wave action cuts into fossil deposits below the tide line and washes them back onto the beach. Beach collecting, like spoil bank collecting, requires very little in the way of equipment--a good pair of walking shoes, a pail, some small plastic bags or vials with labels (for fragile specimens), and good eyesight.

Badland collecting is restricted to the drier regions of the world. Badlands develop in soft sediments that readily erode into numerous steep hills and deep canyons cut down though the surface layers by rapidly eroding rains (Russell, 1977). Over many years various strata are widely exposed revealing the rich fossil evidence of the past. The classic examples of this terrain are the "mauvaises terres" of Big Badland National Park in South Dakota and the Grand Canyon, where the action of a river has cut a mile-deep gorge through largely fossiliferous sediments of the past.

Collecting in this type of country is not without risk. Loose gravel and knife-edge ridge crests greatly increase the likelihood of falling. During summer field seasons heat is another special concern, and adequate water must be supplied. Once the appropriate area has been selected by consulting previous studies, air photos, geologic maps, and other sources of information, an expedition usually begins prospecting on foot. Preliminary prospecting is simple and involves covering great distances and checking each eroded slope, gully, or mound. Normally only broken fragments are visible coming down the sediments. Occasionally a complete or nearly complete specimen can be found in place.

When a valuable specimen is found, the collector should scout around it for other possible pieces or associations. The next step includes preparing out and applying a plaster jacket to the specimen. The location of specimens should be noted on a map and referenced to known landmarks. Once jacketed, the hard job of carrying it out must be solved. Normally collecting is done exactly the same as spoil bank collecting. Specimens are placed in either pails or plastic bags with field labels. Smaller specimens are protected by placing in plastic vials.

Site Preparation and Layout

When a major concentration of fossils (a site) is discovered, a special strategy for its excavation must be developed. A systematic approach will help preserve the maximum amount of valuable scientific data hidden there with a minimum of effort. Planning the site and sketching the disposition of the fossil bearing sediments are to be undertaken before significant digging commences.

A field foreman should be selected to supervise the working operation of a site. There is often an advantage in having this individual be someone other than the scientist involved with the site. The field foreman insures that all tools are available at the beginning of a day's work and all accounted for at the end of the day. The foreman must know all field procedures and be able to assist or supervise individuals having problems during the day's operation. Often the handling of large heavy equipment is also a prerequisite. Either the foreman or the scientist must maintain detailed records in a field notebook for the site. Map data, important stratigraphic data, and bone orientations are compiled in this book. Long bone dipping angles or planes are measured using a Brunton-type compass, and the data with coordinates are written in the field notebook.

The first step to be taken at the site is to determine boundaries or total extent of the fossil bearing sediments, if possible. This is usually done by digging test trenches or exploratory pockets in the area of the expected site. Once these boundaries have been established, steps are to be taken to remove the top layers of sediments commonly called overburden. When the site is small enough and manpower is available, a shovel brigade is all that is necessary. Larger and more complex sites require the use of heavy equipment in the form of front-end loaders or bulldozers. Sometimes draglines must be used. The overburden is removed to approximately a foot above the fossil bearing sediments. This level is adjustable depending upon the site itself.

Once the boundaries have been determined for the site, it is prudent to construct a map of the site. A rough sketched map with directions, approximate distances, and representation of the more obvious features is better than none. The best way, in the interest of scientific accuracy, is to map the site with an alidade and plane table. The collector will find numerous books on the subject, such as J.W. Low's *Plane Table Mapping.*

After mapping the site, a grid system can be set up (Figure 4-2). Standard grids are 1 to 3 meter squares. The grid is started at an arbitrary zero point, usually on a corner boundary of the site. A Brunton-type handheld compass may be used to set up the grid, or for greater precision a surveyor's transit. R.F. Spier describes the use of transit and basic surveying skills in his book, *Surveying and Mapping: A Manual of Simplified Techniques.*

Laying out a grid system and mapping a site are time consuming endeavors, but they are essential components of a scientific excavation that allow for the systematic recovery of fossils and make the interpretation of distribution and frequency of fossil remains much easier. Once a zero, or starting point, for the grid has been chosen, the grid can be laid out in the required intervals. Heavy duty stakes can be driven into the ground to mark at least one corner of the grid. String or wire stretched between the stakes serves to further delineate the individual grid squares that have unique numbers. All material collected within one grid square is assigned the grid number. By convention, a worker assigned to a specific grid location usually stays there until the grid is worked down to sterile matrix.

Proceed with extreme caution--until the preservation of the bones is known, all work must be executed carefully. In friable sands or clays, trowels and awls usually accomplish the slow process of working down to the bone layer. More consolidated matrixes, such as cemented sandstone, consolidated tuff, or limestone, may require the use of small picks, chisels, and dental picks. Chisels should never be used as levers, but for cutting only. Jack hammers are standard field equipment in certain terrains. Safety must be considered when using any of these tools. Protective glasses should be worn to prevent matrix chips from striking the eyes, and in certain situations hard hats and even steel-toed boots may be advisable (Figure 4-3).

Once the bone layer is reached and the fossils begin to appear, the matrix must be removed more carefully. Fossil preservation varies. Some bones remain punky and soft and will disintegrate easily, whereas others have been mineralized to a silicon or limerock hard material. Usually dental picks and brushes are all that is required to work around the fossil layers. Additional picking with a geology pick may be required. Some cemented or concretionary layers may be best left for laboratory preparation. A consolidant material is needed during the field excavation to seal and glue broken specimens before removal from the ground (Converse, 1976). The type of consolidant will depend on the site itself. In very humid conditions most materials with either an acetone or alcohol base will not work. The consolidant will not harden and will turn milky white over the specimen. A form of water base sealant must be employed. Several forms are available, such as polyvinyl alcohol, polyethylene glycol 4000, or white glue. The latter should be used as a last resort. It is very difficult to soften and remove once it has dried. A molten wax could be used to encapsulate a fragile specimen. Beeswax is a hard form and can be flowed over the specimen with either a small electric soldering iron or gas torch.

Since the 1950s major advances in vertebrate paleontology have stemmed from special techniques for recovering certain pockets such as point-bar deposits, or certain layers that have rich concentrations of small bones and teeth. This matrix material should be carefully collected and placed in burlap or cloth bags with proper site coordinates and carried to a stream, water hole, or back to the laboratory for careful screen washing. Except for prospecting by the "hands and knees" or the "anthill" methods, it is not efficient to devote much time to searching for micro-material at the site (McKenna, 1962).

At the end of each day's work all the collected specimens and plaster jackets are transported back to the museum or to a storage area near the work site or campground. It is very important to keep the work site clean at all times, and the removal of collected specimens is one phase of this process. Another very important procedure in keeping the site clear is the removal of the overburden from the site as soon as it is dug from the ground. Starting this practice early eliminates the need for moving of this material over and over again as the site expands.

During the excavation of a grid locality the removal of matrix should be a uniform digging operation, with large sections of the square being taken down and the remaining area brought down shortly to the same level. Tunnelling must never be done. This may cause many problems and possibly destroy valuable scientific data if cave-ins occur. Remove each level entirely over the square grid before going deeper.

Field Equipment and Safety

A simplified listing of basic field equipment follows. Each excavation site differs, so that this compilation is only a general one. Matrix removal is usually performed by using geology picks, shovels, chisels, trowels, or screwdrivers. Once the fossil-bearing layer has been reached, more careful excavation work must be done by using smaller tools, such as dental picks and brushes for the harder matrixes and awls, trowels, and brushes for softer ones. All removed fossil material should be placed in pails or plastic bags, but must have a field label in each. Smaller specimens may need to be wrapped in tissue and put in a plastic vial before being placed with other specimens of the same coordinates.

Plaster jacketing material in the form of burlap and bulk plaster of Paris or the simpler plaster bandage form must be planned into each excavation.

Depending upon the environment of the site, a hardening solution consolidant should be included in a water soluble form for wet conditions and an acetone or alcohol-based consolidant for dry surroundings.

Accurate records must be maintained. A waterproof field notebook is required to record more accurate data on specimens as they are located and removed from the site. A Brunton-type compass should be used for correct orientation of bone specimens, giving direction and angles of dip within the site. This information must be recorded in the field notebook.

Field safety must be taken into consideration at all times. Safety glasses should always be used when chipping away at the harder matrixes. When using a chisel with a hammer, gloves should be worn to prevent severe injury to the hands. When the site is located in high country or any area where there is a chance of rocks or other objects falling from above, hard hats should be worn. The use of mechanical devices, such as blocks and tackles, winches, or hoists, prevents the chances of back injuries due to improper lifting.

Plaster Jackets

Collecting fossils from spoil banks or working a quarry sometimes turns up specimens that are too fragile to remove from the matrix. Immediate removal would create an impossible jig-saw puzzle to piece back together. In such cases it is well worth devoting a little time to properly preparing a plaster jacket. A plaster jacket is one of the paleontologist's most important field tools (Auffenberg, 1967). It provides the same first-aid for a broken fossil as a plaster cast does for a broken arm or leg. It holds everything in place and stabilizes the surrounding matrix until proper repairs can be made back in the laboratory.

Plaster jackets can be prepared for quite small specimens, or even for very large ones that require heavy equipment for removal from the site. Three forms of jacketing material currently exist for the paleontologist. The oldest form consists of strips of burlap cloth material saturated with a mixed solution of plaster of Paris and applied over the specimen. A faster and more convenient form is the plaster impregnated gauze bandage, commercially available for medical purposes. This form just requires a short dip in a pail of water and is ready to be applied to the job. Its size, however, makes it inappropriate for large specimens. The third and newest form is manufactured by the Surgical Products Division of 3M and listed under the trademark of Scotchcast Casting Tape. Scotchcast is a knitted fiberglass fabric impregnated with polyurethane resin. Its primary use is making casts for broken limbs. To start the chemical hardening reaction, simply dip in water for 10-15 seconds. After approximately six minutes the tape becomes rigid. In paleontology, Scotchcast is especially useful as a jacketing material when working under water.

When a plaster jacket is needed, the first step required is to prepare the specimen to receive the jacket. The matrix sediments must be carefully removed from the top of the specimen. This allows the complete outline of the fossil to become visible. A protective layer of sediment must be left surrounding the specimen. Enough should be allowed so there will not be any shifting of the fossil once jacketed. A trench must be dug down around the outer perimeter deeply enough to insure that the complete fossil will be safely held within the jacket. If the matrix consists of cemented sandstone or consolidated volcanic tuff, geology picks and chisels are required, and it will take a much longer time to prepare the jacket (Figure 4-4).

Once safely below the specimen, a deeper undercutting must be performed, giving the prospective jacket a "mushroom profile." This will allow the jacketing material to be tucked far enough under the specimen so the jacket will not shift or slip off when breaking loose from the ground. Allow a wide enough trench during the above operations so one can work comfortably around the fossil and still have a space into which it can be turned.

After the specimen has been generously undercut, the fossil needs a protective layer. Paper toweling or toilet tissue works very well for this job. All exposed bone must be covered with at least 1/4-inch of paper to prevent it from sticking to the plaster. Any very low pockets can be filled with loose sand or clay. Dampen the paper so that it will conform to the bone contours more easily--sprinkling water over the paper with a brush usually does a fine job.

Plaster bandage, or whatever material is preferred, is applied over the entire pedestalled section of matrix. Wrap the jacketing material in all directions over the specimen and matrix, making sure to cover the undercut portions with a generous supply of the material. Depending on the size of the plaster jacket, thickness should range from 1/4-inch thick on smaller jackets up to several inches for larger ones. The thickness of the jacket is very important in providing the necessary strength to prevent its collapse. For jackets larger than a foot or two in diameter, reinforcement is required. This can be accomplished by using tree limbs that may be found near the site, reinforcing rods, or pieces of lumber (Whitaker, 1965). The wood is incorporated within the manufacture of the jacket with several layers of jacketing material applied over them. Simple carrying handles can be included with this reinforcement. Just allow the wooden pieces to protrude out of each end of the jacket far enough to get a good grip on them (Figure 4-5).

Once an appropriate thickness of the jacketing material has dried, the specimen is ready for removal from the ground. In softer soils or clays a spade or shovel is all that is needed to separate the base from the ground. Carefully push the shovel under the jacket until it breaks free. On harder matrix, a chisel and pick are usually required to loosen the base of the pedestal. On very large jacketed specimens it is convenient to construct some form of skid under the specimen. This can be done while the jacket is still resting on a thinned-down pedestal and makes removal easier if heavy equipment is required to drag the jacket out of the site. The skid can also be used as a platform to transport the specimen back to the laboratory (Figure 4-6).

Once the jacket is turned, additional plaster material should be applied around the base. This will completely seal the specimen and sediments tightly within the jacket for safe removal to the laboratory. Sealing the plaster jacket also will insure its security during long term storage should its final preparation be delayed.

The final label on the outside of the jacket should be applied with a broad-tipped marking pen, giving all the data and the orientation of the specimen. The label should be visible when the jacket is stored on the shelf.

Besides the plaster jacket, there are a few alternatives for removing fragile specimens. Heavy duty aluminum foil, in multiple layers, can be molded around smaller specimens. This simple jacket is sufficient to protect the specimen from further deterioration until it can be removed to the lab.

A new material, available at most hardware stores, is foam sealant. This styrofoam-like material comes in a handy spray can which is easily portable. Cover the specimen with a clear plastic food wrap (like Saran Wrap) and mold it to the contours of the specimen. Then spray the foam sealant around the specimen, smoothing it with a spatula or by hand (a rubber glove should be worn). The foam jacket dries in about 45 minutes and forms a protective shell that is strong and lightweight.

When collecting fossils from a moist clay matrix, it is often possible to use the clay itself as a jacket. The stickiness of the clay will hold broken specimens together if they are not too large. They need to be wrapped in toilet paper or foil to prevent drying out.

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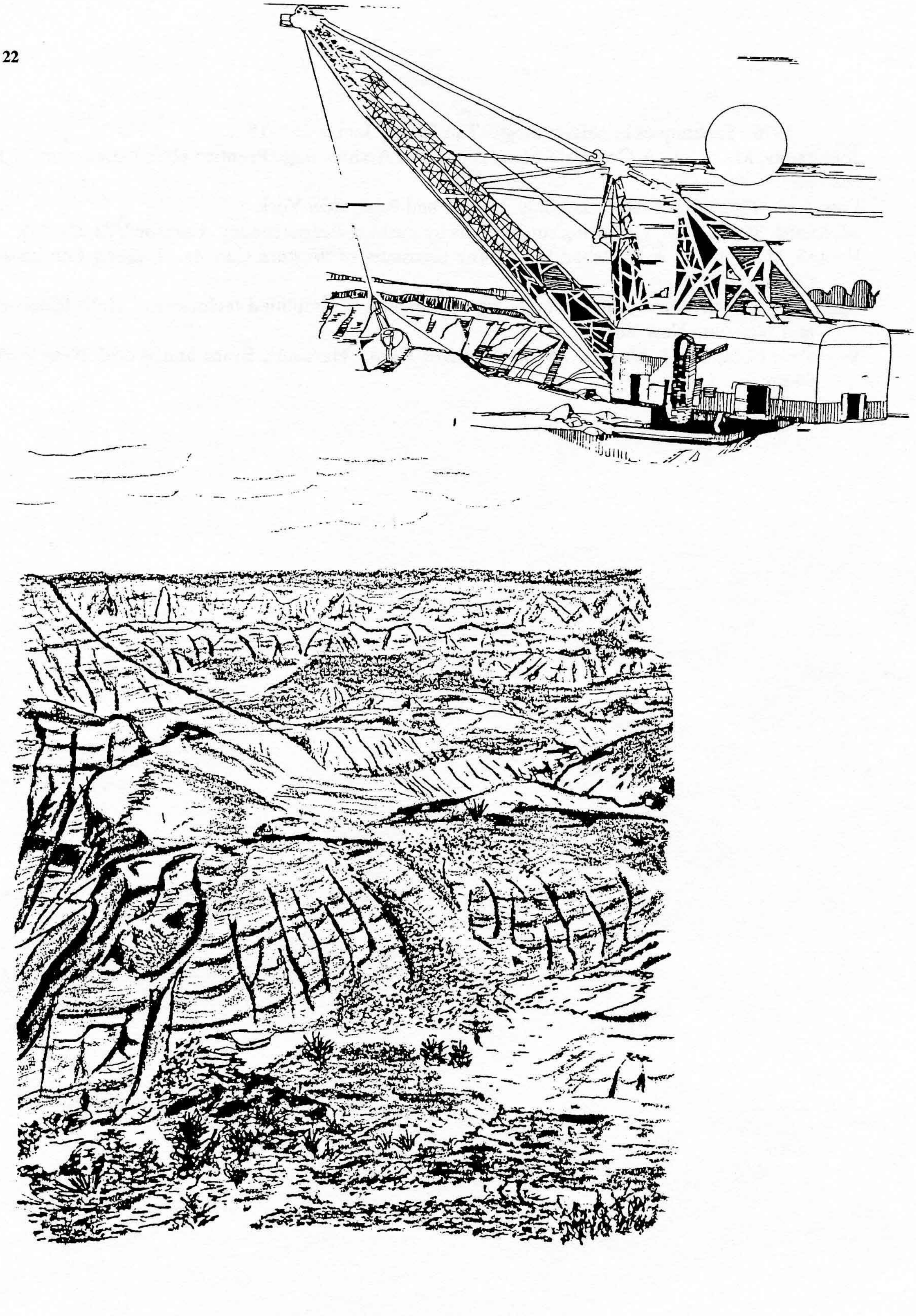

FIGURE 4-1. Two forms of spoil bank collecting. Top, mining operations; bottom, badlands.

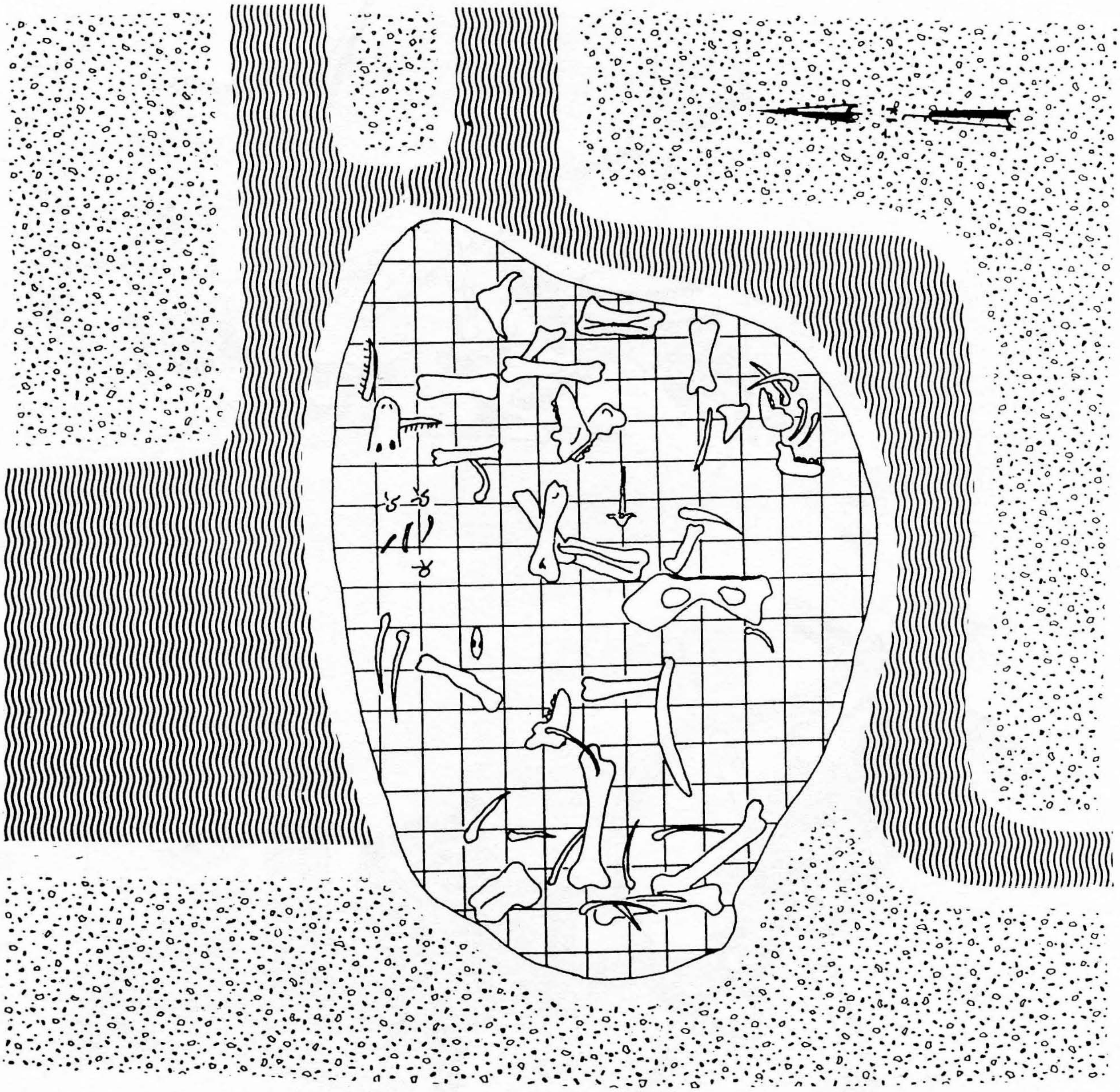

FIGURE 4-2. Site layout showing fossil location within a grid system. Data recorded in field notebook could show sketch like this. Coordinates would be western half tract 17, Block 1, Plat 9 of Palm Beach Farms, Sec. 28, T. 43S, R. 42E, Palm Beach County, Florida (Converse, 1973).

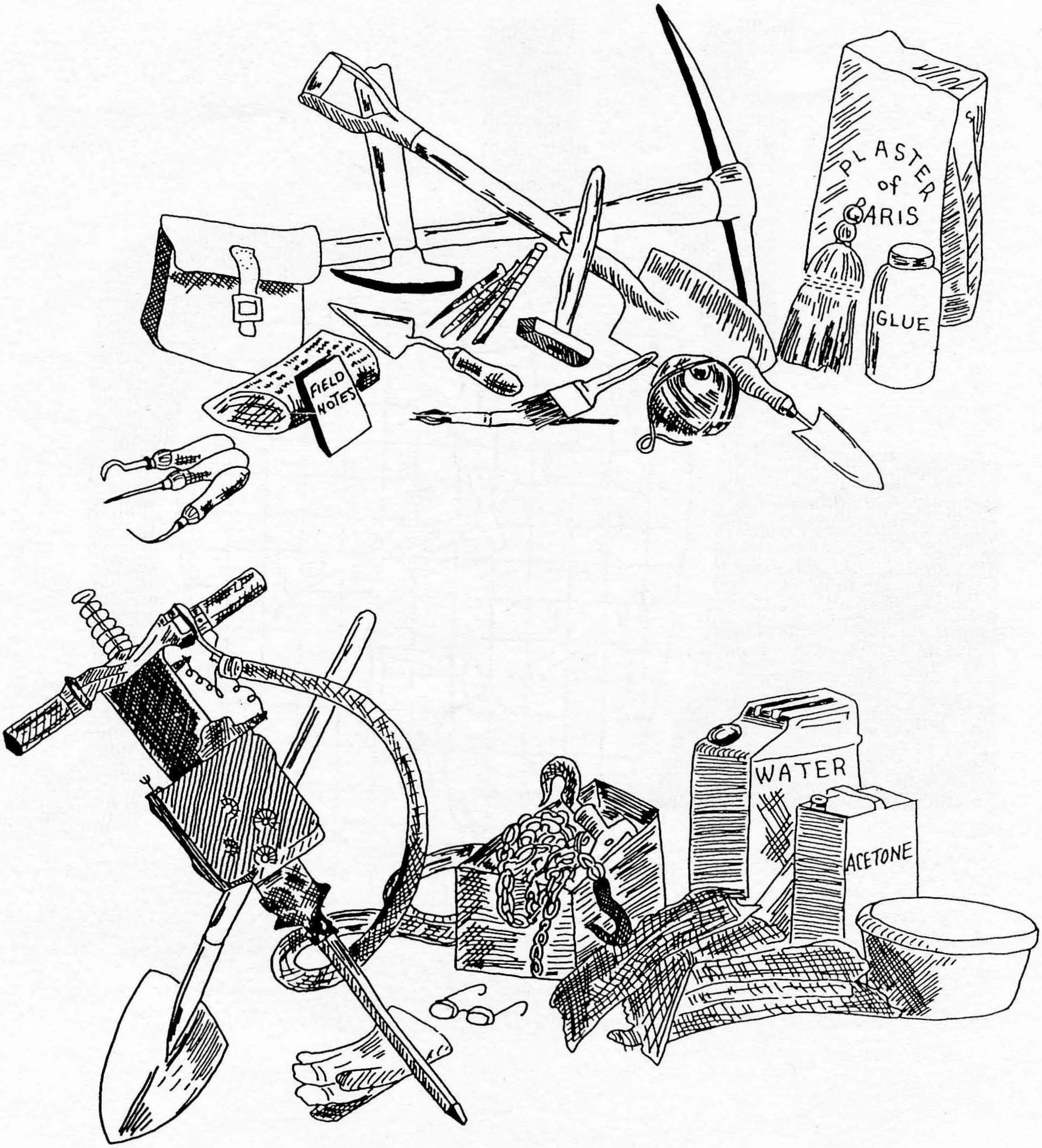

FIGURE 4-3. Some of the tools used to excavate a site.

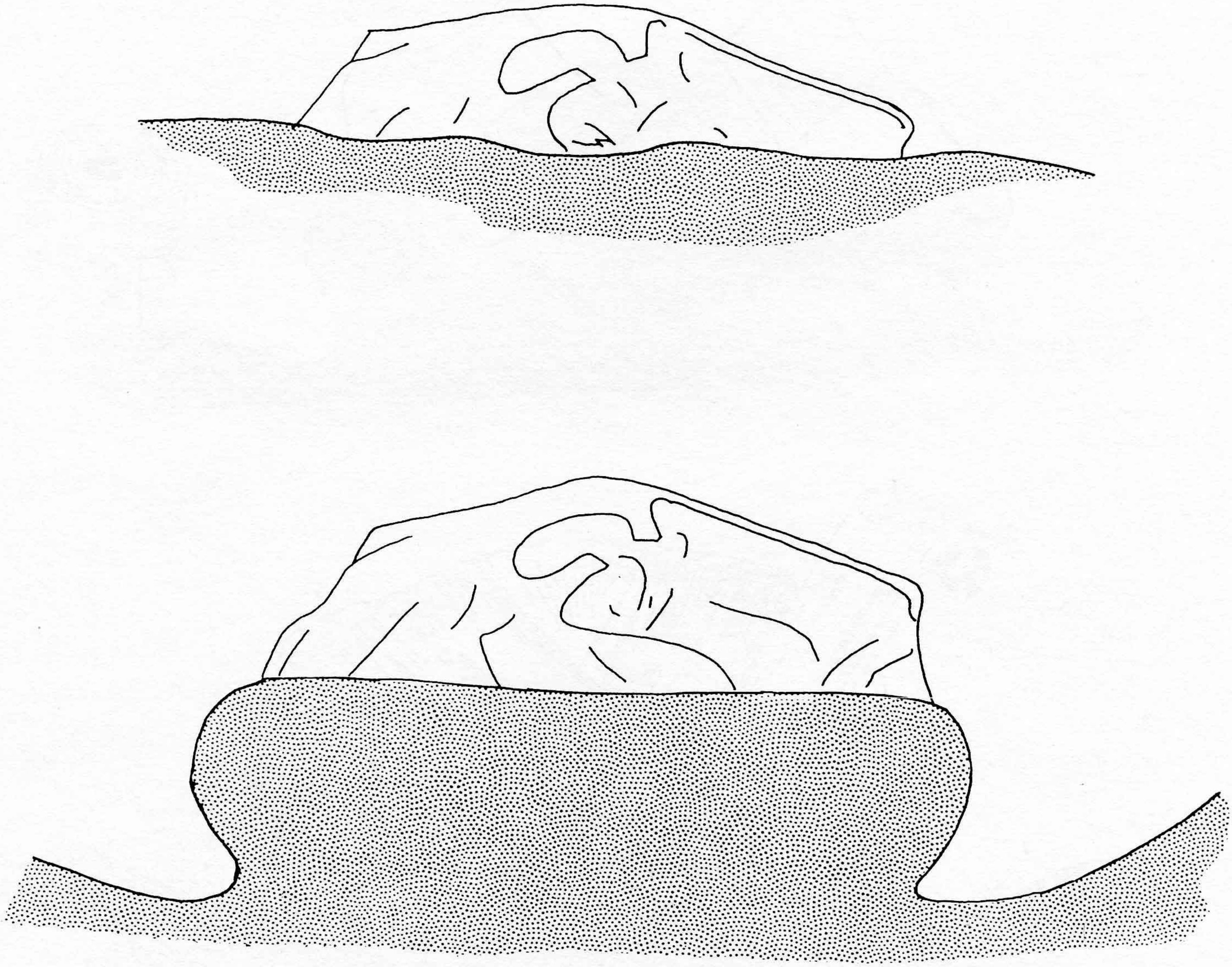

FIGURE 4-4. **Top, specimen as discovered in the ground. Bottom, excavation work is done leaving ample matrix around the specimen and a generous undercut.**

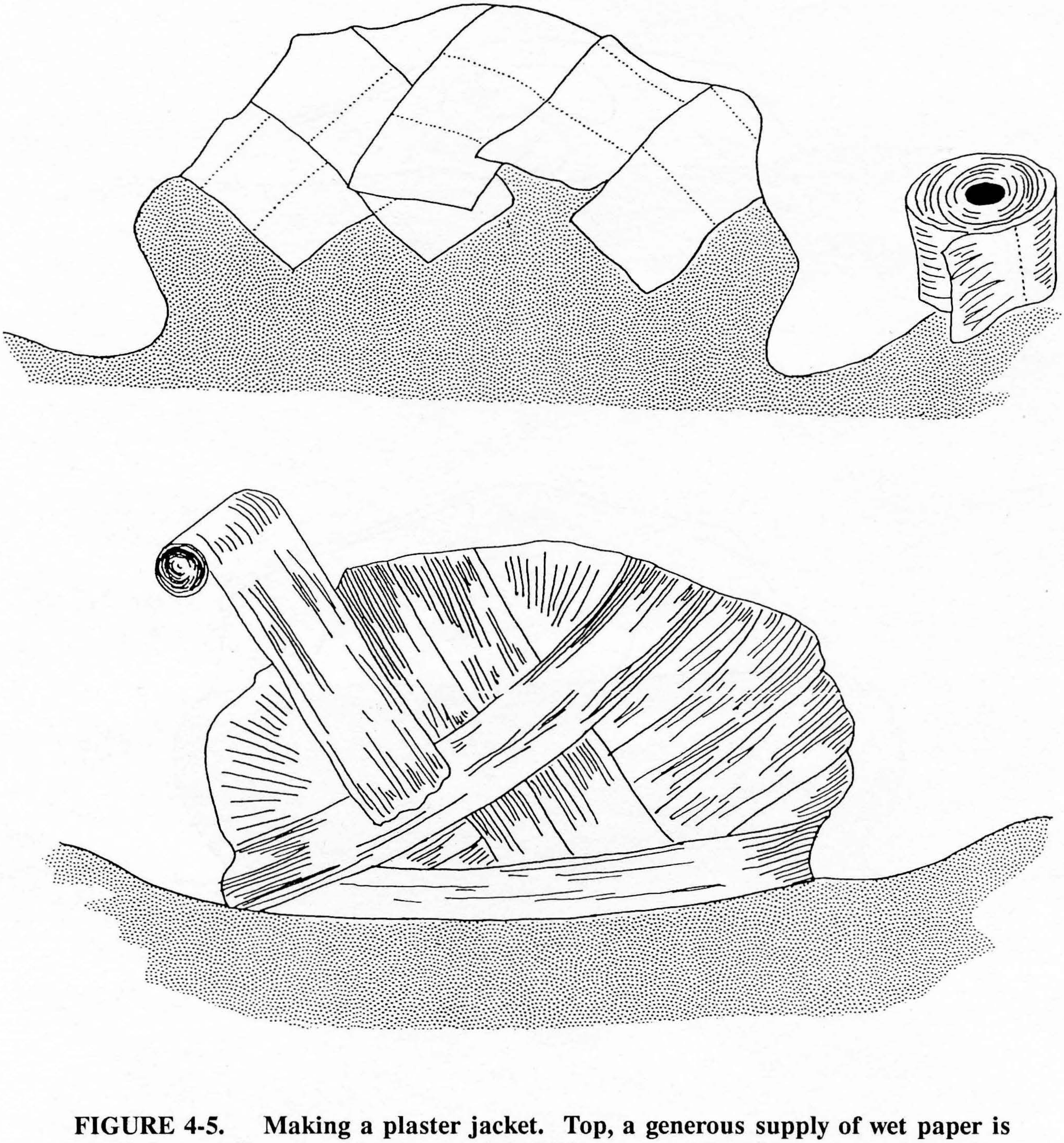

FIGURE 4-5. Making a plaster jacket. Top, a generous supply of wet paper is applied over all exposed bone material. This prevents the plaster from sticking to the specimen. Bottom, plaster saturated burlap or plaster bandage is wrapped around the pedestaled matrix and specimen.

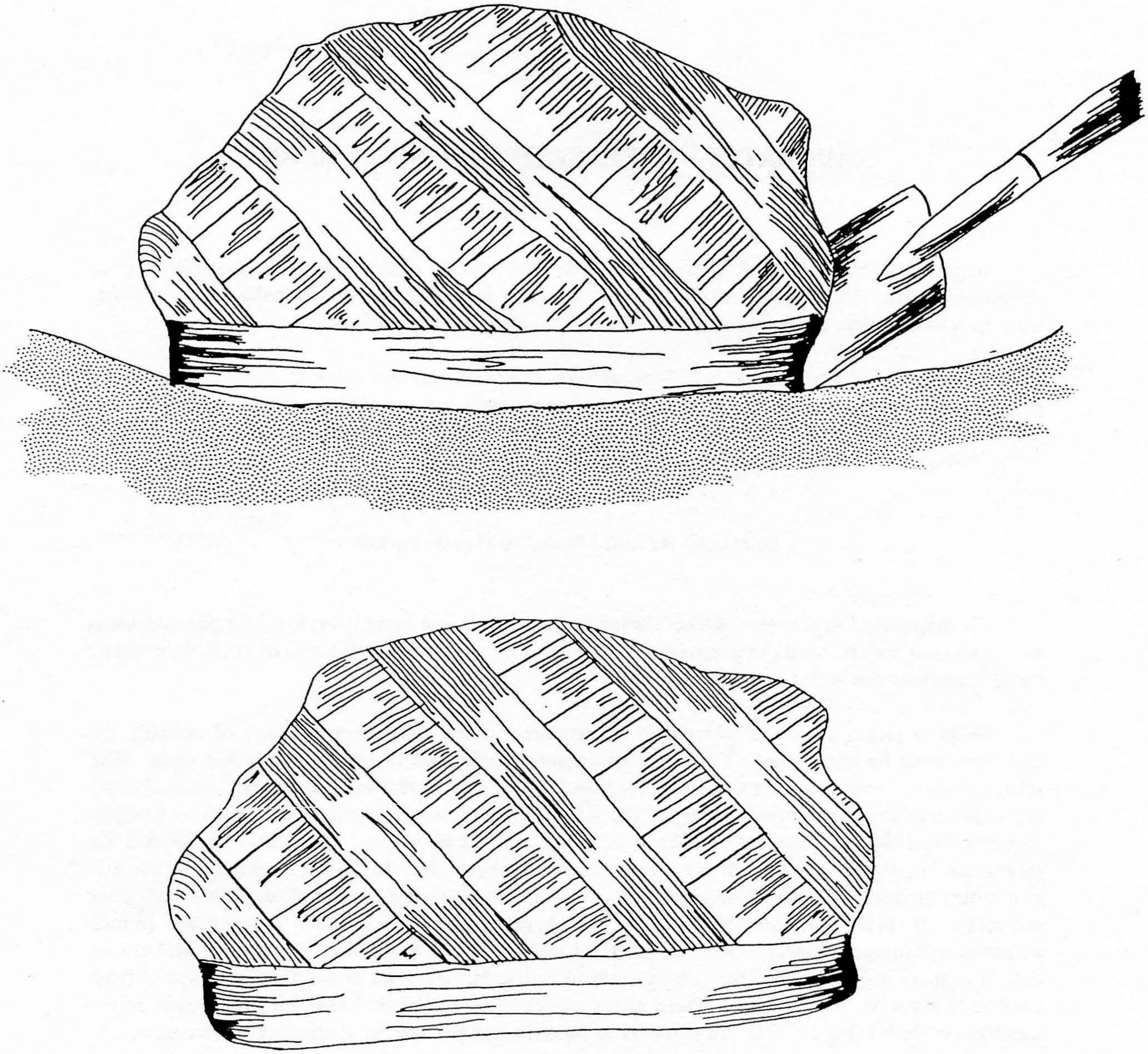

FIGURE 4-6. Removing the plaster jacket from the site. Top, the pedestal is broken from the ground with a shovel or pick. Bottom, after removal from the ground, the base is sealed with jacketing material, and the jacket is labeled and removed to the laboratory

Chapter 5

LABORATORY PREPARATION OF SPECIMENS

In paleontology the word "preparation" has been used to describe various operations, from the consolidation and repair of fossils to their extraction from the matrix, or finally their mounting for museum displays. A "preparator" is one who prepares fossil specimens.

Most material coming into a collection from the field requires work to some degree in the preparation laboratory. These operations can range from just washing away the sediments to a major three-dimensional restoration of a flattened specimen. Thus the preparatory operation plays an important role in any fossil collection.

Specimen Removal from the Plaster Jacket

As mentioned in Chapter 4, the plaster jacket serves as a protection for a fragile specimen within its own matrix, until the preparator can slowly clean away the sediments or rock, then repair the specimen as the jacket is worked down.

When a jacket has been selected to be prepared in the laboratory, the task of opening the bandages must be performed. There are two common methods of cutting the jacket open. The most common form is using a small hand saw--a keyhole saw works well for this operation. Simply cut a thin straight line around the top of the jacket. As the saw penetrates the plaster and begins to enter the soft paper protection, one must avoid going any deeper. One can feel around the jacket and know when the lip will come free. A more modern tool for jacket opening is an electric cast cutter (made by Stryker Company in the U. S.). The 2-inch diameter blade of this saw does not rotate. It rocks back and forth a short distance, making its use safer than rotary saws. In fact, its major advantage is safety. One can place a hand on the blade while it is operating and not be cut. It is specifically designed for cutting casts from live humans. Its blade dulls less rapidly from hard sediments or sandy plaster. Here again one can feel the blade break into the inside of the jacketing material (Figure 5-1). In a matter of seconds a jacket can be opened with this cast cutter.

Not all plaster jackets are small or thin enough to be easily opened with hand saws or electric cast cutters. Jackets containing the bones of large animals--such as sloths, elephants, or dinosaurs, for example--are often two or three inches thick. In such cases, other methods of opening them may be necessary. One method is to use a masonry blade on a skill saw. If the preparation area has an air compressor, pneumatic saws, such as those used in auto body shops, are very effective as cast cutters. These are small hand-held tools that use abrasive rather than sawtoothed blades. With both the skill saw and the pneumatic saw, protective goggles, gloves, and dust masks are advised for operator safety. Also, extra care must be taken not to damage the fossil with these high-powered tools.

Care and good judgment is required when opening plaster jackets with any type of cutting tool. Depths of cuts must be guaged so they only penetrate the plaster shell. If a careless collector applied the plastering material right next to the bone, the cast sawing is very risky indeed. This is one reason that labels on jackets should indicate the orientation of the specimen inside.

Once the jacket has been opened, the careful process of matrix removal begins. On softer sediments, dental picks and soft brushes can be used. Dental picks are used to scrape thin layers of matrix, while the brush sweeps away the loosened debris. Harder matrix will require more stringent measures. Small chisels can be lightly tapped with a leather mallet. The hard matrix is taken down a couple millimeters at a time to the specimen. The remaining matrix is flaked and chipped away using dental picks. A small vibrating air-hammer can be employed in this operation. It is faster, but care must be taken not to create so much vibration that the specimen shatters or cracks. Rotary grinding tools can also be used to remove the hardened sediments.

During the entire matrix removal process, careful observation must be made of the specimen itself. When cracks are noticed, a thinned solution of consolidant must be applied immediately. A watered-down (acetone solvent) solution of Butvar B-76 has proven to be the most satisfactory consolidant at the Florida Museum of Natural History. Apply only to the bone surface areas, avoiding contact with the matrix (Figure 5-2). This thinned solution will penetrate deep into the cracks, sealing and hardening the specimen for safe removal.

There are times when compact clays can be softened by applying water to the clay. But this increases the danger that expansion might crack the specimen. If there is a chance of the specimen cracking or other possible damage, an application of acetone or alcohol will do the same softening. Butvar B-76 cannot be applied over a water soaked specimen. It will not bond and will turn milky white in the areas where applied. If this situation occurs, simply stop all work on the jacket and allow it to dry out. The Butvar can be removed by brushing with a solution of acetone until the milky color disappears.

As one works down into the jacket, the high walls left behind can be trimmed in the same manner as the jacket was opened. Vibrations should be kept to a minimum with the bone material exposed.

If the specimen was properly hardened as it was excavated from the jacket and all matrix has been removed, the specimen can be carefully lifted from the jacket and the opposite side cleared of sediments.

Specimens that are unearthed in a fragmented state require very careful attention. As the sediments are removed and the specimen has been cleaned of as much debris as possible, a thin coating of consolidant must be applied. Do not try to reassemble the specimen while it is still in the matrix. Keep all bone fragments in their broken alignment. The specimen is consolidated and all sediments are removed prior to its removal from the jacket.

If the specimen being prepared is fragmented into many pieces, it is helpful to record the fragments and their position before removing them from the plaster jacket. A photograph will suffice, or the specimen may be traced by laying a sheet of clear plastic material (a plastic bag or piece of VizQueen) over it. The fragments may even be numbered if desired.

When removing the fragments from the jacket, be sure to remove only one or two at a time. They may be superimposed on traced outline on the plastic sheet. These fragments should be cleaned and glued before removing the next few pieces. By removing and repairing a few pieces at a time, the preparator has more control over the reconstruction and is less likely to lose track of where the pieces fit (Figure 5-3).

Consolidation and Repair of Specimens

Few fossil sites produce specimens that are in perfect condition. It is much more common to find fossils that are crushed or broken into many pieces. Even if a bone looks perfect when first discovered, it can deteriorate rapidly once removed from its protective matrix. This is especially true of bones found in aquatic environments. It is safe to say that virtually every fossil will require some degree of consolidation and repair (Figure 5-6A).

Before the advent of modern consolidating agents and adhesives, fossil preparation was done with natural substances. such as animal glues, gelatines, shellac, and waxes (Rixon, 1976). An old favorite for large specimens, such as the elephant group, was beeswax. This substance can be melted down in large vats and the bones immersed into the wax until all trapped air has been released. The bone usually boils or foams as the air is released into the wax solution. The wax penetrates into all the cracks and pores replacing the air. Remove the bone from the wax and allow to drip dry. Any excess buildup in the drip areas can be trimmed or melted off. Beeswax seals and hardens a specimen making the bones suitable for a museum mount. Many of the great mammoth skeletons assembled in the nineteenth or early twentieth centuries were preserved in this manner.

Today most of these natural substances have been replaced with plastics. As mentioned earlier in this chapter, Butvar B-76 is the preferred consolidant at the Florida Museum of Natural History. Butvar is manufactured by Monsanto Chemical and is a tradename for the generic product called polyvinyl butyral. There are several formulas of Butvar currently being marketed, but Butvar B-76 seems to be superior because it can be dissolved in either acetone or alcohol. Faster drying occurs when acetone is used. All other forms can only be prepared with alcohol. Butvar B-76 can be thinned to a very thin solution and makes an excellent material for sealing a specimen. Its low viscosity allows it to penetrate into all cracks to great depths. The acetone quickly evaporates leaving the hardened resin behind. Thicker solutions make excellent glue.

A number of people who first tried Butvar B-76 made a major mistake in mixing this material. As mentioned previously, it is manufactured in a crystal form, and when acetone is poured over the crystals, the surface coats over with a gel and the remaining crystals are difficult to get into solution. The crystals must be slowly allowed to fall into a predetermined amount of acetone. As the crystals float down into the acetone, they begin to gel. A heavy concentrated stock solution can be prepared in this manner. A heavy-duty laboratory mixing device must be used to prepare the concentrated solutions.

To date Butvar B-76 has been used in the trade for approximately twenty years. Its durability over this period has proven superior to other comparable products. There has been no noticeable discoloration or brittleness. Alvar and Glyptol products do become brittle and usually turn amber or yellow in color in a decade or two.

There are several other plastics that are worth mentioning. Polyvinyl acetate has been around for more than forty years. For consolidation, it should be mixed with toluene. When made into a solution using acetone, a good adhesive is produced that will dry quickly. A water soluble form is currently being sold by department stores, construction suppliers, and hardware stores under such trademarks as Elmer's Glue All, Flexbond, and Wilhold White Glue. This commonly used form of white glue will bond to nearly all solid materials and dries leaving a colorless bond. The polyvinyl glue is shock resistant and is not affected by extremes in humidity.

The water solubleness of the white polyvinyl glue makes it very useful in preparing fossil material (Wilson, 1965). It is especially valuable where laboratory or field preparation demands work in high humidity, or where specimens cannot be allowed to dry before preparation (as in many underwater specimens). This glue dries very slowly and allows for greater penetration and bond. The polyvinyl acetate adhesive can be thinned according to its use. A normal laboratory dilution is about one part water to two parts white glue.

Many preparators have avoided using white glue in the laboratory because it is difficult to remove. Soaking in water sometimes softens the bond enough for safe separation, but the safest removal method is applying heat to the previously set glue. This softens the glue enough to permit rearrangement or resetting of the various fragments. Softening with heat is useful for inserting additional pieces into previously glued sections. After cooling, the glue returns to its original adhesive properties. A butane torch works well for isolated application of heat. A laboratory oven can also be used. The oven temperature should be set at approximately 150° F. When using the torch method, the flame should be passed over the bonded area quickly, then removed to allow the heat to diffuse. Repeat this procedure until the glue softens enough for dislodgement and/or rearrangement of the section.

In acid development of specimens, polybutylmethacrylate has proven to be the most widely used plastic to strengthen bones. This material is normally dissolved in a solution of methyl ethyl ketone. Toluene can be used if the above is not available, but will take longer to dry.

Another plastic used for acid development of fossils is polymethylmethacrylate, an almost universally obtainable plastic. In the United States it is listed under the tradename of "lucite." A quick drying solution can be obtained by mixing with ethyl acetate or chloroform.

A more widely used plastic is polyvinyl alcohol, the advantage of which is that it is soluble in almost nothing but water. A thick paste is made by mixing the powder with a small amount of water. This lump-free paste can be thinned to be used as a glue or as a mold release agent during casting operations.

Polyethylene Glycol 4000 is a wax-like substance that has been used for a number of years, especially by archaeologists. It has served as a primary preservative for waterlogged wood. The main advantage of this wax is its low melting point and ease of dissolution in water. The latter makes it a valuable field consolidant for wet specimens. It can be easily poured over a collection of fragmented bones in the field, then removed to the laboratory for careful removal and repairs. It can be used safely in the development process of fragile thin specimens. One side of the specimen can be poured into a block of PEG 4000. The opposite side can be delicately worked and hardened. The process is reversed for working on the opposite side. Excess wax can be removed by rinsing off in warm water.

Epoxy resins and plastic woods are primarily used as adhesive substances. They are applied where strength would be required in joining two pieces together. Both epoxy and plastic wood are used extensively to restore missing areas in most museum mounts, because the fact that they can be sculpted and modelled is an advantage.

A repair epoxy that has proven to be superior to all others in the past fifteen years is a product manufactured by Travaco Laboratories and marketed under the trademark of Marine-Tex. Marine-Tex is a heavy duty, plastic patching material developed primarily for boat repairs. It is a heavy paste that molds and holds to any shape. It will work at temperatures as low as -60° F. and as high as 300° F. When cured it will not shatter like other epoxies. Repairs can be made to specimens, which then can be placed in hot treatment solutions, such as beeswax, without the repairs falling apart (Figure 5-4). All other epoxies tested failed to hold up under these conditions. Marine-Tex will harden in 3 to 5 hours at room temperature, but can be speeded up by applying under an infrared lamp for 3 to 10 minutes. The epoxy will harden in 5 to 10 minutes. Normally this material remains workable for 30 to 45 minutes. Ring stands and sand boxes are excellent tools for supporting specimens during repair or reconstruction (Figure 5-5).

Many field-collected specimens do not require special treatment at the site in the way of a plaster jacket, etc. and are usually brought into the laboratory in a pail or plastic bag. Proper cleaning must be done to make the fossil ready for the collection. A screen washing room is usually available at most large museums. The specimens are brought into this room and placed into the screen trays. Water is gently run over the fossils to loosen the attached sediments. Extra force in removal of the sediments can be applied by using a toothbrush or similar soft brush. When the specimen has been totally cleaned and while it is still in the screen tray, it is placed in a drying rack. The rack can be an open-air type or enclosed cabinet with a forced air fan. After drying, the specimen can be treated with a protective consolidant and then routed into the collection for cataloguing.

Filler Materials

Since the majority of fossils are not complete, at some stage of repair probably they will require a filler material to complete missing areas. This can be done for cosmetic as well as practical reasons. A limb bone, for example, may be in two pieces with the edges making contact along a small surface of ¼ inch or less. The contact is good, but since large portions of the middle shaft are missing, even glue would not hold the specimen together. The use of filler materials in this situation is necessary to produce a specimen that can be handled.

A common filler material used in preparation labs and by taxidermists is a finely ground paper maché. When mixed 50/50 with plaster, it produces a strong, durable filler material. Plaster of Paris also is used by itself. There are many types of fillers on the market that can be adapted to the prep lab. Wood doughs, auto body filler, epoxy putties, and other plastic compounds are just a few of the many available filler materials. Epoxy resin and 5-minute epoxy glues can be mixed with sawdust to make the highly pourable fillers needed to fill cracks in tusks (Figure 5-6B).