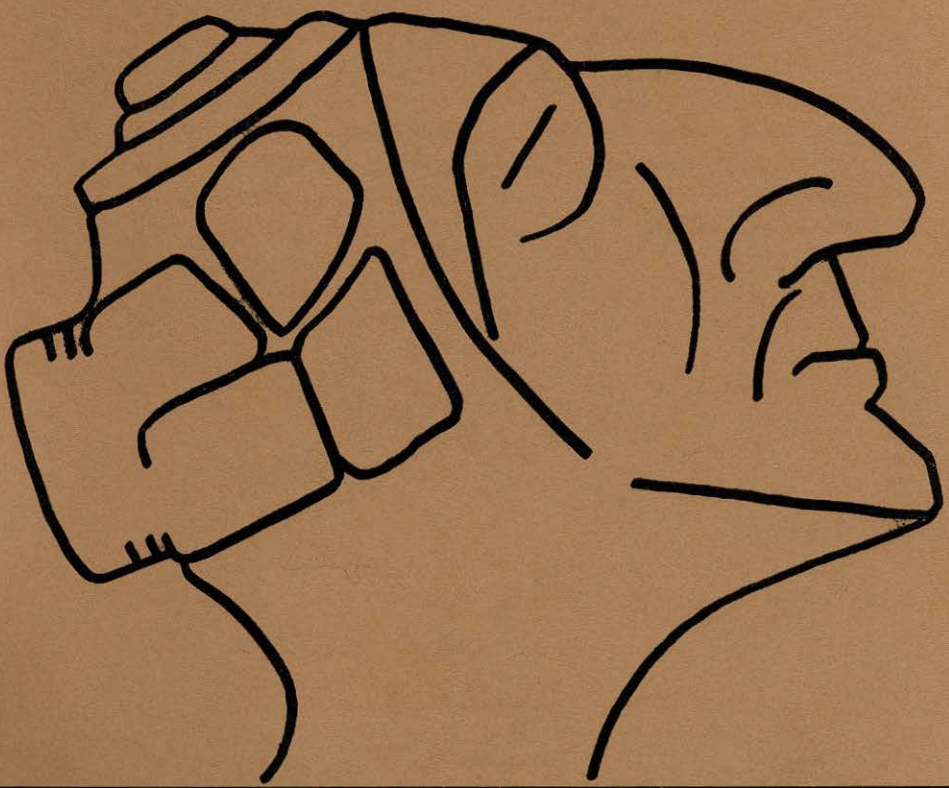
SOUTHERN INDIAN STUDIES



Volume XV October, 1963

The *Southern Indian Studies* was established in April, 1949, as a medium of publication and discussion of information pertaining to the life and customs of the Indians in the Southern states, both prehistoric and historic. Subscription is by membership in the North Carolina Archaeological Society (annual dues $3.00) or $1.00 per year to institutions and non-residents of North Carolina.

PUBLISHED

by

THE ARCHAEOLOGICAL SOCIETY OF NORTH CAROLINA

and

THE RESEARCH LABORATORIES OF ANTHROPOLOGY

THE UNIVERSITY OF NORTH CAROLINA
Box 561
Chapel Hill

Southern Indian Studies

VOLUME XV OCTOBER, 1963

THE CONSERVATION AND PRESERVATION OF ARCHAEOLOGICAL AND ETHNOLOGICAL SPECIMENS

By

BENNIE CARLTON KEEL

CONTENTS

Chapter

I. Introduction 5

II. Ceramics 9

III. Bone, Shell, and Antler 15

IV. Stone 19

V. Metals 21

VI. Wood 29

VII. Textiles 39

VIII. Skins 47

IX. Registration and Storage 55

X. Insect Control 59

Bibliography 61

CHAPTER I

INTRODUCTION

The artifact is the basic unit of archaeological study. Artifacts represent both ideas and activities of prehistoric peoples. The relic and the context in which it occurs are the prime resources of archaeological interpretation. Since the process of gathering artifacts destroys the physical context of their occurrence, the archaeologist preserves this context for future study in notes, drawings, and photographs. The ideal disposition of the collected artifacts is a museum or some other repository for the "fossilized evidence of human behavior." Artifacts often deteriorate or decay because they have not received proper preservation or storage. While some classes of artifacts require none, or at the most, only minimal preservation, others require quite extensive preservation if they are to survive for further study.

Ethnological collections, which represent the material culture of contemporary peoples, are also subject to the agents of decay. In fact, the proper treatment, especially in terms of storage, is of utmost importance because these collections are generally composed of raw materials which have long vanished in an archaeological situation.

Since archaeological specimens and items of ethnographic interest are basic to anthropological studies, it is surprising that there is very little in the professional literature dealing with their preservation. No standard American manual of recent date for the preservation of archaeological and ethnological specimens exists. In fact, the only recent English source covering this subject is *The Conservation of Antiquities and Works of Art* (Plenderleith 1956). To be sure, it is an excellent source, but because it is based primarily on techniques of preservation developed for specimens from northern Europe and the Near East in British National Museum collections it has limited utility to American archaeologists. Restricting its usefulness to an even greater extent, perhaps, is the use of British trade names for preservatives.

Various industries have developed numerous techniques for the preservation of their products. These techniques have generally remained unknown to the archaeologist or to the curator of collections in the typical university anthropology laboratory or small museum.

In a university or small museum preservation usually is the responsibility of the collector. The preservative techniques used in these places usually achieve less than maximum results. Preservation is often conducted with makeshift equipment, and rarely does the collector have the benefit of council of the professional preservation technician.

This study will describe the traditional preservation procedures used by anthropologists and museum curators. In addition, practices developed by various industries for the preservation of their products will be included if such techniques can be applied to archaeological or ethnographic specimens.

In order to preserve a given specimen, one must know something of its physical and chemical properties and of the processes of decay or deterioration that will affect it. With each class of artifacts data pertinent to decay are presented.

Special emphasis is given to preservation techniques that do not entail special equipment. The economic aspects of the techniques are considered. Expensive techniques that require elaborate equipment and complicated procedures are omitted from the study if an equally suitable and cheaper way of accomplishing the same end has been found. Familiar trade names are used instead of technical names because I believe the trade names are more useful.

The opening chapter deals with the preservation of ceramics and glass. Potsherds, except in preceramic sites, are usually the most numerous artifacts recovered from archaeological sites in North America. Glass and porcelain objects, which do not originate in aboriginal American cultures, are nonetheless quite common at sites occupied during the historic period. Hopefully, methods of preserving them will interest those involved in Historic Sites Archaeology.

Chapter III considers bone, shell, antler, and artifacts made of these materials, and skeletal remains.

Metals, treated in Chapter IV, are generally limited in occurrence to historic period sites and to colonial sites. Despite certain exceptions in American archaeology, from a quantitative point of view native metals are rather uncommon. Observation indicates that, aside from the ubiquitous ceramic refuse, objects of metal rank first in frequency on colonial sites. Metals are perhaps the most complicated class of artifacts to preserve because

of the special characteristics of each group of metals. Ironically it is the varying properties of metals that produce the multitude of characteristics that make them so important to man.

Chapter V discusses techniques for preserving stone. The nature of stone is such that it normally requires only cleaning and proper storage. However, our contaminated atmosphere does induce corrosion of some minerals.

The next three chapters deal with artifacts made of perishable materials. Wood, textiles, and animal products are susceptible to many kinds of deterioration. Because they are rarely found in an archaeological context, it is mandatory that they be given our best preservation efforts. In most cases, objects of wood, skin, gut, fur, hair, hides, leather, feathers, and plant fibers are found under extremely arid conditions, conditions which are not common to most of North America. Paradoxically, they also occur where they have remained submerged in water, but under special conditions, e.g., the absence of bacteria. In the preservation of perishable materials and metals one most frequently finds techniques developed by various industries that are applicable to archaeological or ethnographic specimens.

Correct identification of the material from which a specimen is made is basic to its preservation. A preservation technique suitable for use on specimens of one class of materials might damage or even destroy those belonging to another class of raw materials. Proper identification of the raw material is also necessary for proper registration and description. The person charged with the responsibility of cataloguing must have a wide range of experience with raw materials or the aid of specialists who are willing to make identifications for him. A well thought-out system of registration, cataloguing, and storage should be operable in any institution that serves as a repository of cultural specimens. The well-preserved collection may deteriorate if storage conditions are shoddy. If a specimen is not readily available for study, the time, cost, and labor that have gone into its preservation have little value. Ideally, a storage system should be simple, economic to operate, and secure. Chapter IX, dealing with registration, cataloguing, and storage, discusses the minimum requirements that all institutions should try to meet. The requirements are stated in general terms because the registration and storage system in use at any institution will depend, to some degree, on the

nature of the collections and the personal attitudes of those in charge.

The attacks of insects are one of the leading dangers to ethnological collections. A few notes on insect control are offered in the final chapter. Some steps can be taken against future insect damage during the preservation and cleaning of perishable materials. The most satisfying control of insects is usually accomplished by contractual agreements with local reputable exterminating companies.

CHAPTER II

CERAMICS

Moist clay is plastic. The application of sufficient heat makes it a stone-like material. This heating process is called "firing," whether it occurs in an open fire or a closed kiln. Immersion, even prolonged soaking in water, will not restore clay's original plasticity, although such treatment of low-fired ware may make it softer and more friable than when dry. Artifacts of baked clay are highly resistant to chemical action and rank with stone in endurance. In many archaeological sites only these two types of materials have lasted from the aboriginal occupation. Ceramics, because of their permanence and sensitivity to cultural changes, are among the foremost materials used in archaeological analysis (Shepard 1957: 1-5).

Freshly excavated pottery is often thoroughly soaked. Unglazed, low-fired ware is apt to be very soft and fragile under such conditions. Such pottery should receive minimal handling until it has been air dried and some of the original hardness is restored. Delicate specimens and painted ware should be tagged as a warning to the individual who will be responsible for their cleaning.

Pottery can best be cleaned with a soft-bristled brush under running water. Household detergents such as Fab, Tide, or Sail may be used if care is taken to avoid the removal of fugitive paint decorations. The potsherds may be allowed to soak in the weak detergent solution for a very short period, but in no case should they be allowed to soak for an extended period of time. In cleaning low-fired ware, the surface should be brushed lightly with only the pressure required to remove the soil. Care must be taken in the scrubbing not to erode the surface or the edges of the sherd.

The removal of deposits of lime or chalk may be difficult but can be accomplished by soaking in a very weak solution of hydrochloric acid. Prior to the soaking a small sherd should be tested in the solution. If the ware is tempered with crushed shell or limestone, or if the pores of the sherd have filled with deposits of calcium carbonate, the resulting effervescence may cause the pottery to disintegrate.

Unglazed earthenware is easily weakened by salts absorbed while covered in the soil. These salts may be removed by repeated soaking in water followed by a final soaking in mineral-free water to remove any chlorides. An economical source of demineralized water is a commercial "soft water" service. Several such services use an ion-exchange rosin for the removal of minerals. This demineralized or "soft" water is suitable for most preservation chores at a cost of about one-sixth of that of distilled water. After drying, desalted sherds may need strengthening, easily achieved by impregnating the sherds with a solution of Gelva dissolved in commercial-grade acetone. Painted decorations which might be dissolved in water may be stabilized by covering the decorated area with a coat of the nitrocellulose solution before they are soaked.

Removing salts which have entered through cracks in glazed pottery and porcelain can be a slow process and may be hastened by soaking in alcohol. The alcohol process is not so effective as the distilled water solution, but satisfactory results may be obtained from longer soaking periods. If the glaze is not too loose, repeated packing in wet paper pulp is also effective.

If devitrification of the glaze has taken place, producing a cloudy or opaque appearance, the clear glass quality can be restored by local application of a one per cent solution of hydrofluoric acid for a few minutes at a time, followed by thorough washing and polishing with rouge paper. If devitrification has reached below the immediate surface a coating of clear lacquer will restore the original quality of the surface. The repair and restoration of ceramics is adequately treated in the literature. Plenderleith covers the subject most thoroughly (Plenderleith 1956: 326-339). Other sources are also valuable (Printup 1961: 10-14; Wolff 1939: 53-61, 1960: 75-87; Torrey 1940: 136-138). The basic steps are given below.

After the sherds have been cleaned and allowed to dry, it may be worthwhile to repair or restore some vessels. Before sorting the many sherds into individual vessel components, label each sherd to insure preservation of its archaeological provenience. The number identifying the sherd should be placed on its interior face.

Each piece should be fitted into its correct position and secured by the application of a small coating of a cellulose cement, such as Duco Household Cement, to the binding edge of the sherd.

If possible before any two sherds are glued together, the correctness of fit should be checked by fitting a third sherd that has an edge in common with both sherds. Such a procedure cannot always be followed but will, when applicable, insure a better fitting together of the vessel.

Duco Household Cement is highly recommended for this type of work. A substitute is Gelva dissolved to the desired consistency in commercial-grade acetone. After the application of the cement, the edges of the sherds should be pressed firmly together, the fit checked by a third sherd as pointed out above, and any excess cement wiped away immediately. Once the cement has set, the joint can be allowed to harden in a sand box. Any handy container can serve as a sand box. Some workers prefer a coarse grade of washed sand to a finer grade of sand because the coarse sand does not enter cracks between sherds so easily as does fine sand, and because it can be more readily removed. After the cement has set work the sherds carefully down edge-wise into the sand to support the joint. When working with smaller sherds, it is advisable to hold them until the cement has set, then to balance them by placing one sherd in the sand with the joint above the sand. This procedure insures that the joint will not be spread by sand's working into it.

Large sherds will occasionally become warped from dampness and soil pressure. No amount of careful fitting can make warped sherds fit properly. In such cases the restorer has two alternatives: he can work together the warped sherds as neatly as possible, ignoring the resulting gaps; or he can break the large sherd into several small sherds, cementing them to fit by making allowances for the warping. The former choice is usually the wiser. Heavy joints are strengthened by cementing thin strips of acetate across them. If the pottery is extremely porous, it may be desirable to size the edges of the sherds with a thin solution of cement or shellac before attempting restoration or repair.

To fill gaps in the vessel caused by missing sherds, apply a flat piece of plasticine to the interior surface of the vessel as a backing, and fill the gap with molding plaster (plaster of paris) mixed to a creamy consistency. After the plaster has set but before it is dry, it can be cut to the desired contour and smoothed with a sharp knife and sandpaper. During the shaping process be careful to avoid damaging the surface of sherds adjacent to the

plaster patch. I prefer Durham's Water Putty, a non-shrinking, plastic compound, to plaster.

Two methods exist for coloring the patches. Some prefer to mix dry color into the plaster before water is added. The color of the surface of the vessel can be approximated in this manner. The restorer must remember that the addition of water will darken the dry pigment-plaster mixture which will return to its original color when dry. Many workers prefer to patch vessels with plaster and then to use oil paints mixed with turpentine to paint the restored areas. It is common practice to produce a slight difference in color between the original portion and the restored portion of a vessel lest the technician be accused of trying to mislead. If one wants the reconstructed area to resemble the original surface texture of the vessel, the plasticene can be pressed into a surface area of the original vessel to produce a positive mold. The prepared area is then placed over the gap from the outside and the patching compound applied from the interior of the vessel. This procedure has accurately reproduced the surface of cord-marked and fabric-impressed vessels in the collection of the Research Laboratories of Anthropology at the University of North Carolina. Areas restored by this method blend in surprisingly well with the original portions; however, on close examination, one can isolate the reconstructed area.

If sufficient sherds are present to indicate the shape and size of a vessel but there are not enough sherds for reconstruction of the vessel by the preceding method, the following procedure can be used for vessels with circular orifices.

Outline the interior rim of the vessel from a section of restored rim sherds. Complete the circle by continuing this arc. Find the center of the circle by bisecting a diameter. The circle represents the inside surface of the vessel at its orifice: the center of the bisector represents the center of the vessel base. Determine the inside profile of the vessel from the available sherds. Transfer this inside profile to a piece of masonite or plywood to make a template. The center point of the vessel base on the template must coincide with the perpendicular from the center of the bisector of the vessel orifice. Mount the drawing of the vessel orifice on a turntable. Mount the template, base up, beside the turntable so that when a sufficient amount of clay has been placed on the turntable and the turntable rotated, the template produces an interior mold of the vessel. Next, place the sherds in

position on this mold and fill the spaces with Durham's Water Putty. The restored surface can be worked to the proper finish and contour in the same manner as a plaster patch. Color the restored area by either method previously outlined.

Articles of glass which have begun to decompose should be treated in the manner used by Alan Albright (Smithsonian Institution). The specimens of glass are cleaned with running water and soaked in a one percent solution of acetic acid for a week. Change the solution on the third or fourth day. Remove the acid at the end of the week by washing in distilled or demineralized water. A litmus paper test of the wash water will show when the acid has been removed. After the glass has been neutralized it is soaked in commercial-grade acetone to remove all water. When dry, the object can be repaired as are ceramics. The shine is restored by a light coating of clear plastic such as Krylon.

CHAPTER III

BONE, SHELL, AND ANTLER

Living bone is a complex structure of minerals and organic materials. The minerals are calcium phosphate, lesser quantities of calcium carbonate, and trace compounds. The organic materials include ossein (a bone protein), fats, and blood components. Bone occurs in a compact, dense form or as a cancellous substance such as is found in the articular ends of the long bones or in the centrum of vertebrae.

The mineral salts impart rigidity and hardness to bone while the organic compounds give it resilience and toughness. The decalcification of fresh bone by prolonged maceration in dilute mineral acids leaves it so pliable that it can be tied into a knot. The removal of the bulk of its protein and the alteration of its calcium content leaves bone pure white, friable, soft, and porous. Burned bone which is not completely calcined does not reach the fragile stage and, though light in weight, may be quite strong.

Fossilization occurs when the organic constituents are replaced by mineral salts which enter the bone in solution. Bone preservation is encouraged by basic soils. Acid soils are likely so to destroy bone that no trace is found in excavation (Cornwall 1956: 204-208).

Bones provide data on the diet of prehistoric people. The skeletal remains of the people are important for obvious reasons. The artifacts made of bone offer cultural insights. Faunal remains recovered from archaeological sites give vertebrate zoologists data on range and size of species in the distant past (Parmalee 1963: 88-89). Numerous procedures have been developed for strengthening bone encountered in archaeological excavation. All of these entail the application of some dissolved solid.

Once bone has dried, it is fairly strong unless it has been completely calcined. A preservative that has been used on bone in the field must be removed in the laboratory before the bone can be cleaned. The field archaeologist should specify as part of the packing data what preservative was used. Shellac can be removed by soaking in alcohol; nitrocellulose preservatives by soaking in acetone. After the preservative is removed, clean the specimen with a brush and running water. Select a brush whose

bristles are firm but not stiff. Cleaning with a soft-bristled brush takes longer and consequently the bone becomes wetter. A brush that has very stiff bristles may injure the bone. Bone should be kept as dry as possible. After the bone has been washed it should be allowed to dry slowly at room temperature to prevent checking or scaling. Drying may be hastened by baths in alcohol or acetone of commercial grades.

The process I use is quite simple and consists of soaking the bone in a thin solution of Gelva dissolved in commercial-grade acetone. When bubbling has ceased the bone is removed from the solution and allowed to drain for a few minutes. It is then rinsed in acetone to remove the Gelva from the surface. The treated bone is placed on waxed paper and allowed to harden. Some techniques call for the drying to take place in atmospheres of the preserving solvent (Plenderleith 1956: 156; Cornwall 1956: 214). I have used a water-soluble seran plastic (Experimental Latex OX-2144, Dow Chemical Company) in the field and in the laboratory. This material used on wet bone in the field has enabled me to recover specimens that would have been otherwise lost. In the laboratory I have used it on both bone and shell with satisfactory results. The principal drawback is that it is insoluble in common solvents. I have found acetone-soluble preservatives advantageous because they are readily removed. Artifacts preserved with them are easily repaired with such acetate cements as Duco. Many technicians have used with great success a vacuum desiccator to impregnate bone (AJPA 1936: 449-450).

A vacuum desiccator is a device that allows water to evaporate rapidly by lowering the atmospheric pressure. Impregnation of a specimen in a vacuum tank is more complete because air is removed from pores in the object and replaced by the preservative. Also, the preservative is forced into the specimen when the vacuum is released.

A vacuum device can be bought from concerns that manufacture laboratory equipment or can be made from locally available parts. Such a device was made by Rees-Jones (1962: 67-71), and is cheaper than one of similar size obtained from commercial sources. Dunton (1964: 40) describes a simple vacuum desiccator made from a heavy metal can, a vacuum gauge, valve, and aspirator. This device cost about $9 and seems adequate for most preservation needs.

This tank was made by fitting a rubber gasket to the lid of a heavy can and fitting a stop-cock (connected to the aspirator with a rubber hose) to the bottom side of the can. Operation consists merely of placing an open tray of silica gel in the can, putting on the lid, turning on the water, and closing the stop-cock when maximum vacuum is reached. The vacuum is held until the specimen is dry. To impregnate a dry specimen, place the solution in the vacuum tank, put the specimen in the solution, seal the tank, and create a vacuum. Release the vacuum and remove the solution and the specimen from the tank.

The vacuum desiccator can be used to dry metals, pottery, porous stone, etc. It facilitates the impregnation of all porous objects.

A solution of 10 parts acetone to 1 part Gelva gives the desired strength and penetrates bone quite readily. The strength of the solution can be varied according to the judgment of the technician. A large-mouthed crock with a heavy lid is a suitable container for the Gelva solution. Grease the lip of the crock with vaseline to insure a tight seal to check evaporation of the solvent. Should the solution turn milky, water has been introduced and the solution should be discarded.

Antler has properties identical to those of bone and can be treated similarly. Shell is basically calcium carbonate. Calcium deposits which may occur on bone and antler can be removed with dilute acid, but under no circumstances should acid be used indiscriminately on shell (Johnson 1941: 9-10). Soaking shell in a Gelva solution will preserve it.

Restoring and mending bone, shell, and antler is similar to cementing pottery sherds together. The use of a sand box for balancing the repaired specimens is mandatory. A joint that needs recementing can be broken by the local application of acetone or by soaking the specimen in acetone.

CHAPTER IV

STONE

Artifacts of stone are the first evidence of man as a tool making animal. Many authorities (Dart 1956: 317-338) speculate that wood and bone were used for tools long before man turned to stone, but it is objects of stone that give us much of our understanding of the development of man. Stone is the most durable of all materials used by man.

The preservation of stone artifacts is not difficult. The durable quality that makes stone ideal for tools also makes it the least troublesome material to preserve. Stone specimens ordinarily need only a good scrubbing under water with a firm-bristled brush to remove the soil. Storage is simple: the artifacts should be placed in dust-free and dirt-free environments to reduce any further expenditure of cleaning labor in the future. In cleaning objects of stone take care not to remove any decorative paint. Such objects as the statues from the Etowah Site in North Georgia (Larson 1954: 20) or the painted celts from the Peachtree Site, North Carolina (Setzer and Jennings 1941, Plate 24) are examples of artifacts which would have been damaged by indiscriminate scrubbing. The encrustations of salt crystals that appear on porous stone specimens buried in salty soils are removed by immersion in running water until the salts are dissolved.

Statuary, which is excellently treated by Plenderleith (1956: 294-319), falls beyond the scope of this study. The occurrence of such objects in North America is so rare that, if they are encountered, their treatment should be supervised by someone trained in preservation techniques.

The restoration of artifacts of stone is identical to that of ceramics. Projectile points that have been broken can be repaired with Duco Household Cement. Missing areas can be modeled with wax or with Durham's Water Putty.

CHAPTER V

METALS

Many large museums have laboratories and staffs devoted entirely to the restoration and preservation of objects of metal, yet the small museum can, in many instances, successfully undertake the preservation of this material.

Most metals are subject to corrosion. They vary in their susceptibilities to corrosion according to their atomic structures. Corrosion is caused by a series of chemical or electrochemical reactions. The speed of corrosion depends both on the nature of the metal and on its environment. The most effective method of combating corrosion is to find the cause and to correct it.

Minerals in nature tend to form stable compounds and it is to these stable compounds that metals tend to revert. The speed with which a metal object buried in soil corrodes varies with the nature of the metal, the soil porosity, soil acidity, and the presence or absence of water-soluble salts. In the presence of moisture, water-soluble salts conduct electricity and are called electrolytes. The intensity of the electrical activity is low but is, nonetheless, measurable. Electrochemical reaction between dissolved salts and the metal causes corrosion (Plenderleith 1956: 185-191; Gettings 1964: 547-549).

Metals found in archaeological contexts often have water-soluble salts locked in the pores of the corroded surface. These salts, hidden under appearingly stable coats of oxidation or patina, will give rise to fresh corrosion when the object is exposed to air and moisture. Some metals show a progressive growth of surface minerals at the expense of the metallic core, while others form a stable surface oxide which inhibits further corrosion. Malignant patina or "bronze disease" is an example of progressive growth corrosion. The lusterless covering of aluminum exemplifies a stable mineral shield. The patina of an ancient bronze has taken hundreds of years to develop and appeals irresistibly to the collector. Bronze artifacts with such patinas have acquired them while buried in soils relatively free of water-soluble salts.

Three methods of treating metallic specimens will stop corrosion and will, to some extent, restore them to their original conditions. The first is mechanical removal of the corroded sur-

face by scraping, scratching, picking, grinding, brushing, heating, and immersing in cold water; or by sandblasting away the corroded surface and coating with a corrosion-inhibiting substance (South 1962). A second method is soaking in a solution which dissolves the corroded surface and removes the salts trapped in the pores of the metal. The third method is ion exchange (electrochemical reduction), which employs an electrolysis machine or chemicals that set off a reduction process (Nichols 1930; Plen-185-191; Gettings 1964: 547-548).

Different metals react in various ways to a given process. It is necessary to determine the metallic nature of a specimen before treatment. In the case of a valuable object it is advisable to use X-Ray inspection to determine the presence of any characteristics that may be adversely affected by the proposed method of preservation.

Mechanical means may be the only suitable methods for treating many objects because of their size or abundance. Specimens such as cannon, cannon balls, mortars, and anchors may be scraped and brushed in order to remove the corrosion. Some relatively abundant and unimportant items from colonial sites have been sandblasted *without* evidence of harm. Once clean and dry, various coatings protect such objects from renewed corrosion (South 1962). Cannon and other large specimens can be heated with a blowtorch and painted with molten wax or with Rustoleum according to Fairbanks (University of Florida). Rustoleum paint in a variety of colors is sold at most hardware stores. Objects that have a blistered surface should not be heated. Moisture trapped in the blisters can cause disintegration as the moisture turns to steam. Violent popping of the blisters due to the expansion of the steam can injure anyone near the object. Small objects which have been mechanically cleaned can be coated with lacquer or with plastics like Krylon. Both are sold in handy aerosol containers. Smaller objects can be heated in an oven at low temperature to dry any trapped moisture.

Solvents are used primarily in the treatment of objects of iron or steel. Industrial solvents (Rust-O-Lene, Chemtron C-5, etc.) remove rust without affecting the unrusted core. The object is placed in a solvent solution until the ferric oxide is converted to a solute which can be rinsed away. Applying heat speeds the reaction. The process is simple, safe, and economical. The manufacturer of Chemtron C-5 recommends a solution of 1 part of the

chemical to 19 parts of water. Research has shown that increasing the solution strength to equal amounts of Chemtron C-5 and water speeds up the reaction and does no harm to the specimen. The specimen is rinsed thoroughly, dried, and coated with lacquer, dipped in wax, or sprayed with plastic. I have used this method successfully on numerous artifacts.

A simple technique applicable to most metals is electrochemical reduction. The object to be treated is buried in or surrounded by granulated zinc or coarse zinc powder in an iron basin. Enough of a 10 % or 20% solution of caustic soda to cover the materials is added and the solution boiled for about one hour. It is advisable, but not necessary, for boiling to take place in a fume chamber. If the object is incrusted in lime or chalk, the reduction will proceed more rapidly if a 10% solution of sulphuric acid is used in place of the caustic soda solution (Plenderleith 1956: 191-194). Silver objects that are not heavily coated with silver chloride or "horn silver" respond to the reduction method when hot formic acid is used with aluminum granules. Nylon bags can be used to support weak objects.

The electrolytic reduction method, in its most refined form the most technical of all preservation procedures for metals, requires an elaborate apparatus and an appreciable knowledge of chemistry and physics. Nichols (1930) describes this procedure in great detail. Curiously, almost anyone with a minimum knowledge of electricity can very successfully treat certain groups of metals by this method. The process of electrolysis breaks down corrosive compounds by passing a current from the object (cathode) through an electrolyte to an anode. The source of the current can be one of the elaborate machines described by Plenderleith (1956: 360) or such common electrical devices as an automobile battery, a DC transformer used with toy electric trains, or a battery charger (Dunton 1962: 39).

The following steps are recommended for iron or steel specimens. Attach the specimen to the negative pole with copper wire; attach a nail or a piece of sheet iron to the positive pole of the current source. Arrange these poles in a vessel of plastic or of glass that is filled to a level above the object to be treated with the sodium hydroxide electrolyte. I use approximately 1 tablespoon of lye dissolved in 1 gallon of water. The object being treated, suspended from a wooden rod or dowel across the mouth of the vessel, is not allowed to touch the container or the other

pole. After current is switched on, some time may pass before any noticeable reaction occurs. The corrosion is acting as an insulator, but eventually this insulation will break down and the process will begin to clean the specimen. The cleaned specimen is washed until neutral in distilled or demineralized water, then dried and coated with wax, varnish, lacquer, a plastic (Krylon), or some other product that will prevent air and moisture from reaching it.

Specimens of copper or its alloys require refinements in the above procedure. Do not use more than a current of 1 ampere per 20 square inches of surface. Stronger currents may cause damage to the specimen through reaction speed. To control the current place an ammeter and rheostat in the circuit between the power source and the specimen. The ammeter serves as a gauge of the current after it has passed through the electrolyte. After a stable current is established, inspect the specimen every hour. When the corrosion has been removed, wash the specimen, dry it, and coat it. The electrolyte must be kept free from impurities. Lead contamination can be removed by introducing a copper cathode on which the lead will plate. To test for lead, treat a sample of the electrolyte with dilute sulfuric acid until the solution becomes acid. If lead is present, a white precipitate will be formed.

All objects treated by the electrochemical reduction method should be washed thoroughly. Check the wash water to make certain that no traces of acids or alkalis remain in the specimen.

Copper and Its Alloys

Copper and its alloys corrode extensively under some conditions; under others they develop a fine warm coat of patina which some collectors value highly. The patina is the result of reduction of cupric chloride to cuprous chloride in the presence of excess copper. In some cases the cuprous chloride is oxidized and the reduction process is repeated, using up more of the base metal. This reaction is known as malignant patina or "bronze disease." Stored specimens are often found, on inspection, to be suffering from "bronze disease" (Byers 1960: 206). Electrolytic reduction is the best cure for this condition.

Less satisfactory methods for curing malignant patina are soaking for several hours in the following solution:

15 parts Rochelle Salts
5 parts Caustic Soda
100 parts Water

followed by soaking in dilute hydrochloric acid (Plenderleith 1956: 239-241). Rinse the object until it is neutral, then brush it. Coating the dry object with lacquer or with plastic (Krylon) makes future cleaning unnecessary and guards against more corrosion. Many substances on the market (Blitz Cloth, Brasso) are effective polishing agents.

Calcarious deposits can be removed by soaking in a 5% solution of sodium polymetaphosphate, which will also remove the highly-valued patina unless one takes great care.

Restore the ductility of crushed copper objects that are brittle by heating them and plunging them into cold water. Do this after cleaning and before making any attempt to restore the artifact to its original shape (Plenderleith 1956: 254).

Gold

Objects of gold are rarely recovered archaeologically in North America. Gold seldom needs more than gentle washing in mild soap and warm water. It should never be polished because of its softness. A weak solution of hydrochloric acid or household ammonia will remove stains that do not yield to washing. Incrustations of lime can be removed with a 1% solution of nitric acid and careful brushing (Brenner 1953: 371-373).

The potassium cyanide process used in jewelry trade to clean rare metals is not encouraged because it is dangerous. If a specimen demands this process, it should be entrusted to a jeweler or to a museum with the proper equipment.

Gilded objects are cleaned with a soft brush. The use of solvents on such objects can destroy the bond between the gold leaf and the backing. No attempt should be made to straighten distorted objects unless they are of pure gold, which is readily malleable. Alloys of gold often become extremely brittle with age (Plenderleith 1956: 207-211).

Iron and Steel

The ubiquitous dull red coating found on objects of iron and steel and commonly referred to as rust may create either a simple or a complex preservation problem. Bright red rust may be removed by mechanical or chemical means. The darker colored rust may signal that no amount of work will be fruitfully rewarded.

Before deciding which of several methods to use to preserve an object or steel or iron, study several aspects of the condition

of the object. If the metal is completely oxidized any treatment will be harmful. The metal is all converted and the object is chemically stable. The size and weight of the object are pertinent. Small, not-too-brittle objects may be treated by abrasion and blasting, heating, chemical reduction, or electrolytic reduction. Large, heavy items (cannon, anchors, etc.) are most conveniently subjected to mechanical cleaning and to heating. As I have pointed out, heat treatment requires a degree of caution.

Objects recovered in salt water must have the salts removed. Years have passed in reducing such objects into amorphous masses: preservation will also take time. Some objects recovered from salt water have been placed in tanks filled with periodically changed fresh water or in places where they are subjected to a constant flow of fresh water.

If oxidation has reached the stage where not any metal is left, any attempted treatment will be destructive. Sometimes salt infusion cannot be corrected and the artifacts will be lost (Fairbanks 1964: 46).

The electrolytic method is commonly satisfactory. The electrolysis of iron does not require the strict control used with copper or bronze (Dunton 1962: 37-39).

Commercial rust solvents such as Rust-O-Lene and Chemtron C-5 are easily used, economical materials for the treatment of iron and steel. These solvents, bought in stock solutions, are prepared by mixing 1 part stock solution to 19 parts water. Because these rust solvents do not attack the base metals there is no danger that the process will proceed too far (Swift 1959).

No matter which cleaning method is used on iron and steel, the final steps consist of drying and of sealing to protect the surface from new oxidation. Drying may be accomplished by baking in an oven or by heating with a blowtorch. Extract water by immersion in ether, acetone, or alcohol, or with a vacuum desiccator. The surface is sealed by immersing the object in lacquer, wax, or plastic, or by spraying it with any of these substances. Biek and others (1954: 32-36) have tested the effectiveness of several protective films and indicate that beeswax is slightly superior to plastic coatings. Pelikan (1964: 59-66) is experimenting with polyphosphate compounds that react with the metal to form a protective shield. The results of this experiment may offer a new technique for the preservation of artifacts of iron and steel.

Lead, Tin, and Pewter

These materials usually need little cleaning other than the removal of surface dirt. They are never cleaned with abrasives because of their softness. To remove the white lead carbonate, soak in a 10% solution of acetic acid, then soak in a 1% solution of sodium hydroxide. Once the deposits are freed, wash the specimen in several changes of distilled or demineralized water. If the specimen dries in an atmosphere free of acid fumes, an invisible protective shield of patina will form.

This method is not recommended for use with detailed lead objects because lead is slightly soluble in caustic soda and prolonged immersion destroys fine details. Loss of detail also results from the use of the electrolytic method if the specimen is left in the tank after the current is switched off. Caustic soda, if used, must be removed by repeated baths in hot distilled or demineralized water. Remove the object from the bath and dry it in 95% alcohol. Coat it with molten beeswax and drain on blotting paper.

The ion-exchange method (Organ 1953: 49-52) is the most effective and safest method for the removal of lead carbonates or chlorides. A synthetic resin resembling the zeolites used in commercial water softening procedures detaches the carbonate ions from the lead. These ions are taken up by the resin. The resin is regenerated for further use by treatment with nitric acid to dissolve the lead. Wash the resin with distilled or demineralized water until the acid is removed. No active chemicals are introduced and washing the specimen is superfluous. Caley (1955: 49-54) describes the process he used for cleaning lead specimens from the Agora. He soaked specimens in a volume of dilute hydrochloric acid equal to 50 times their volumes. The acid solution was 1 part of reagent-grade acid (specific gravity, 1.9) to 10 parts of distilled water. The specimens soaked from 1 to 2 hours to overnight. The final step was soaking cleaned specimens in a warm 10% solution of ammonium acetate prepared by dissolving 100 gms. in 1 liter of distilled water. The object was then air-dried.

Pewter that carries a fine design is best treated by the ion-exchange method.

Tin can be treated electrolytically with a caustic soda electrolyte or electrochemically using aluminum, magnesium, or zinc powders and caustic soda. Never treat tin with hydrochloric acid because it is soluble in this acid (Plenderleith and Organ

1953: 63-72). Small metal specimens that are brittle or have unique interest can be embedded in a clear plastic (Selectron or Casolite) (Sills and Couzyn 1958: 88).

CHAPTER VI

WOOD

Artifacts of wood or of wood products are subject to several forms of damage: warping, fungus or insect attack, and normal rotting (caused by a combination of chemical and biological attack) are the most common.

Warping occurs when the moisture content between the cells of the wood becomes lower than or greater than the moisture content of the cells. Any restriction placed on an object undergoing the warping cycle will generally cause cracking or splitting. Warping can sometimes, but not always, be corrected or improved. The technique is simple but time consuming. The warped object is moistened and pressure is applied in the direction of correction. After the desired results are attained, careful, slow drying follows with the object protected from further wetting by painting or sealing. Caution must be taken in dealing with objects which have been buried and warped for a long period of time. A permanent modification in cell structure will have occurred and it will be impossible to correct. The elimination of warping is time consuming, often taking months (UNESCO 1955: 149-155).

The main sources of destruction and decay are attacks by the larvae of several beetles, termites, and wood-inhabiting fungi. While the damage can be considerable, the agents pose no real problem in correction. Unfortunately, wood-boring larvae and termites can do a great amount of damage before they are noticed. It is well to have periodical inspections of all wooden artifacts making up the museum collection.

Objects collected in the field that show infection of molds or insects should temporarily be sterilized by the application of fungicidal insecticides. Such objects should be kept separate from uninfected artifacts until they have been treated (UNESCO 1955: 155-165).

Mildew and molds are the typical fungi found on wooden objects. Any traces should be removed by brushing. Stubborn instances can be removed by softening with dilute household ammonia or a solution of carbolic acid in water. Common red mold is very toxic to the kidneys. Specimens exhibiting it should be given thymol fumigation treatment at once. Place the object

to be treated in a sealed box on a rack situated to hold the specimen 18 to 20 inches above a dish of thymol crystals which is placed above a 40 watt electric light bulb. The heat from the bulb will release enough fumes to treat the specimen. Turn off the bulb after half an hour and let the specimen remain in the sealed box for at least 24 hours. Any deposit of thymol on the surface of the object will disappear after a few days. This treatment should not be used on painted or varnished surfaces because it tends to soften them. Care should be taken in handling thymol. It is highly irritating to the skin. Avoid mercuric chloride as a fumigant. It is highly toxic and offers results no better than those obtained with thymol.

Fungus stains may sometimes be removed by brushing them with soap and water or with dilute household ammonia. Some stubborn stains may need the attention of special laboratories; however, stains seldom detract from the appearance of wooden specimens.

A cold solution of sodium fluoride (3-6 oz. in one gallon of water) brushed on in two coats is an effective fungus preventative. Since sodium fluoride is stainless and odorless it will have no adverse effects on the specimen.

Acid magnesium fluoride can be used as a fungus-inhibiting agent but is corrosive, applied by immersion, and not recommended. Protective coatings that contain fungicides and insecticides may be used on objects exposed to the weather in outside exhibits. Of these, Pentacure is almost colorless and is probably the least offensive (Carswell and Hatfield 1939: 1431-1435).

As with all organic substances, the best guard against fungus attack is storage under ideal climatic conditions, 70°F, 50% relative humidity. Excessive moisture can be partially controlled in storage compartments and exhibit cases by the inclusion of anhydrous calcium chloride or silica gel in cloth bags. These should periodically be removed and dried.

Damage by insects can usually be blamed on termites or powder post beetles. The signs of activity of these pests are small holes in the surface of the specimen, fine yellow dust on or near the specimen, piles of discarded wings or dead winged insects found on or near the specimen, and small pellets of digested wood on or near the specimen (Deschiens and Coste 1957: 55-56). Control of these pests can be achieved several ways. Regardless of

the method used, continuous inspection is necessary because of the long life cycles of the insects and to guard against new infection.

The methods employed for the control of insect pests are reduction or increase in temperature, vacuum treatment, fumigation and penetration with a liquid insecticide. The first two methods are not so effective as the latter two, the fourth being the best. Baking at a temperature of 230°F. for 8 hours or overnight, or storage at 0°F. is a stopgap measure that should be used only in emergencies or when fumigation or impregnation is inadvisable. Be cautious—extremes in temperature may adversely affect the specimen.

Fumigation requires an airtight container that has sufficient space for the specimens and the fumigant containers. A convenient laboratory size that will accommodate most specimens is 6'x3'x3'. The removable cover is fitted with rubber gaskets to make it airtight. Trays hold the fumigant suspended on racks in the top of the chamber and are filled through pipes in the covers.

The specimens are placed in the chamber and the top replaced and secured, the screw caps removed, the fumigant poured into the trays, and the screw caps replaced. There is a wide variety of fumigants to choose from but only the most common ones will be considered here.

Carbon tetrachloride is one of the best agents. Nontoxic, noninflammable, and non-explosive, it is safe to use on most specimens, but cannot be used on objects with painted or varnished surfaces because it tends to soften both paint and varnish.

Hydrogen cyanide gas is excellent for ethnographic collections but must be used with great caution. It is extremely poisonous.

Methyl bromide is useful for heavy timbers but has no advantages for use on small specimens and should be avoided when possible because it tends to form compounds with disagreeable odors.

Carbon disulphide is an excellent insect fumigant but is highly explosive, poisonous, and evil-smelling.

The following fumigants are recommended for use in the chamber:

1. Carbon tetrachloride—1 oz. per 8 cubic feet of space in the chamber.

2. Carbon disulphide—1 oz. per 8 cubic feet of space in the chamber.
3. 1 part carbon disulphide mixed with 4 parts carbon tetrachloride—1 oz. of solution to 8 cubic feet of air space in the chamber.
4. 3 parts ethylene dichloride mixed with 1 part carbon tetrachloride.

All of the above fumigants are for unpainted surfaces. The object fumigated should be left in quarantine for at least a month and the fumigation should be repeated to kill any eggs that have hatched (Plenderleith 1956: 123-125). To paraphrase a familiar quotation, "Eternal vigilance is the cost of preservation."

Immersion in liquid insecticide is the most effectve method of ridding objects of insects. The chief drawback is that such liquids stain the objects. Products like gammexane, DDT, pentachlorophenol, chloronaphthalene, metallic naphthanates, and orthodichlorobenzene are effective and are available in many commercial forms. Before using them, one must be sure to check for qualities that would be injurious to or have undesirable effects on the specimen. Penta, a commercial pentachlorophenol compound, mixed with Varsol is most effective and its slight brown stain is not too objectionable, but it cannot be used on painted surfaces. Dusting with Paris Green or sodium silico-fluoride is useful, but not so effective as the previously mentioned procedures (Carswell and Hatfield 1939: 1433; Deschiens and Coste 1957: 57-59).

Specimens of waterlogged wood constitute no major problem in preservation if one exercises care from the time of discovery of the specimen until it has been treated. Waterlogged wood is extremely weak and is easily destroyed because it cannot support its own weight. The steps to be taken are briefly outlined below:

When a waterlogged specimen is recovered it should be removed in a rigid support to prevent breakage. It should not be allowed to dry out—the water held between the cells maintains its form, and if the water is lost, the specimen will warp. The specimen should next be placed in wet moss, cotton-wool, rags, newspaper, etc. A wetting agent and temporary preservatives of 10% wood alcohol may be used. At the laboratory it should be placed in a water-filled container until it can be processed. A bleaching bath may precede any treatment and consists of soak-

ing the specimen in a 5% aqueous solution of hydrogen peroxide for a week. Several processes are available to prevent deformity of the specimen on drying. The inexpensive and uncomplicated alum treatment consists of placing the specimen in a supersaturated solution of potassium alum and allowing it to remain until the water in and between the cells has been replaced by the alum solution. Equipment is simple. An iron, copper, or aluminum vessel large enough for the total immersion of the object, a heat source, and weights to keep the specimen submerged are all that is needed. Enough water to cover the specimen is placed in the container; all the alum that will dissolve at a temperature of 197-204°F is added to the water. This temperature is maintained for about 10 hours. The water level is maintained by adding hot water as required.

After the immersion time is completed, the specimen is taken from the bath while hot and rinsed off in warm water to remove any surface alum. As the water evaporates, the alum crystalizes and prevents any shrinkage. Residual alum can be removed from the surface by brushing with a cloth wrung out in hot water, or with glue size which will tend to form an insoluble film (Deaton 1962: 115-117). Another method of obtaining a desirable surface is to treat the specimen with a mixture of equal parts of turpentine and linseed oil.

The alcohol-ether process is adopted from the well-known technique used for preserving biological specimens. It differs from the alum process in that it fixes the fibers of the wood: alum processing simply fills all spaces.

The alcohol-ether-resin process consists of immersing the specimen in successive baths of these substances. The object is placed in a 95% solution of alcohol and allowed to soak 24 hours per centimeter of length. A second alcohol bath of the same duration is recommended to insure complete removal of water. There is no danger of oversoaking in alcohol. After most of the moisture has been removed by the alcohol, the specimen is transferred to a dry ether bath for two days, and then to the ether-resin bath. After a thorough soaking the specimen is removed: the ether evaporates rapidly, leaving the resin-fixed fibers rigid.

A promising new method for treating waterlogged specimens is immersion in a polyethylene glycol solution (Seborg and Inverarity 1962: 112-119). Polyethylene glycols are various polymers of ethylene oxide. They are soluble in water and in many

organic solvents. Experiments using Carbowax 1000 have been very successful in preserving waterlogged wood.

The slow drying process described above can be omitted by placing the specimen directly into the solution. The technique is quite simple and all that is needed is a watertight container which is large enough to hold the specimen. The solution used is 50% Carbowax 1000, 50% water. The period necessary for treating the specimen may vary from 4 hours to a week or longer. The longer the period of immersion, the less shrinkage, warping, and checking occurs on drying. The period required will, of course, depend on the degree of decay and on the nature of the wood. Open-coarse-grained woods are more susceptible to this technique than the closed-fine-grained woods. Woods that have reached a fairly advanced state of decay give better results than less decayed woods since penetration is greater. Surface cracks and checking can be aided by soaking or painting a solution on the object. Storage must be under rather dry conditions because the specimen may become damp because of condensation and "bleed" the preservative.

The Union Carbide Company, maker of the Carbowaxes, can provide a variety of polyethylene glycols with different molecular weights and some experimentation may be necessary to get maximum protection. The higher the molecular weight, the greater the strength; however, a loss of solubility and penetrability occurs in the heavier polyethylene glycols. In treating a dugout canoe, Dickens (1964) found that the results of this method left much to be desired: a heavier Carbowax might have produced better results.

Wooden objects weakened by fungus or insect attack often need straightening before they can be safely handled or displayed. Straightening can be accomplished by mechanical reinforcement or by impregnation with a consolidating agent. Mechanical reinforcement is best suited to large objects with flattened surfaces. Inlaying X-shaped wedges across cracks will preclude further opening. Dowelling with metal or wooden pegs is often enough to solve the problem. Cracks and joints can often be covered with small squares or "buttons" glued to the surface. Reinforcements of wooden splints glued or screwed to the undersurface or angle-iron braces are useful for large objects (Rosen 1941: 123-127).

Impregnation is the handiest procedure for smaller, more intricate objects and can be used on large objects if necessary. Wax impregnation is commonly used for small, easily handled objects. The method is simple. All that is needed is a container to hold the wax and the specimen and a heat source. Paraffin or beeswax is most commonly used. The specimen must be as dry as possible. Drying can be accomplished by soaking in alcohol and ether baths as described above for waterlogged wood. The dry specimen is lowered into the cool wax and weighted down. The temperature is raised to 222°F and maintained until all bubbling ceases. Then the temperature is raised to 248°F. The length of immersion depends on the porosity and on the bulk of the wood. Excess wax can be removed with turpentine, benzine, or carbon tetrachloride. The last two cannot be used on painted surfaces.

The only serious drawbacks of this technique are accidents with the molten wax. Avoid heating the wax with an open flame. Wax that has been allowed to solidify from a previous process may have trapped water at the bottom of the container and this water, when heated, may turn to steam and cause an explosion of the wax. The other disadvantages of wax impregnation are minor save that specimens tend to have glossy surfaces that may be undesirable in exhibited objects. The advantages are that the technique is simple and economical, and that the waterproof wax tends to stabilize shrinkage due to changes in relative humidity (Wiertelak and Czarnecki 1935: 543-547).

Impregnation with resins is usually accomplished by brushing or injection. Gelva dissolved in acetone at a ratio of 10 to 1 gives good results. The procedure is simple. The resin solution is brushed into the specimen in several coats or can be injected into insect holes.

Gelva has a tendency to turn white from moisture in the air or in the specimen. The white deposit can be removed by washing with industrial alcohol. Alvar dissolved in industrial alcohol tends to develop less of the white residue than does Gelva dissolved in acetone (UNESCO 1955: 154-158).

Flexbond, brushed on or used as a dip, can be used as a strengthening agent. It does not turn white in contact with water, but may give the specimen a soft lustrous finish. William Sears (Florida Atlantic University) has successfully treated specimens from the important Fort Center site by placing them

in a tank containing a solution of 50% water mixed with 50% Borden's Glue.

Repair of wooden objects usually calls for filling in areas or reconstruction. Insect holes and other small blemishes can be filled with beeswax tinted to match the surface. Other patching mediums are ordinary window putty, plaster of paris, and glue mixed with sawdust or pumice powder. Larger holes can be filled with shaped balsa wood inlays or with Plastic Wood (UNESCO 1955: 160-161).

Adhesives must have the following characteristics to be judged adequate for repair work. A good adhesive is transparent when dry, forms a good joint, and has a reasonable setting time and minimal shrinkage. Some of the common types to be considered are hide glue, calcium caseinate, and the modern synthetic resin adhesives. The epoxy resins are the best. They form very strong joints and do not shrink. Success in restoration and repair will depend on the technician's skill, his choice of materials, and the manner in which the directions supplied by the manufacturers are followed (UNESCO 1955: 159-160).

Fragmentary artifacts often must be reconstructed to make them meaningful in exhibits. When all parts are present the task is simply to glue them together. When parts are missing the reconstruction can be made intelligible by securing the pieces to a mold of the whole object. The variety of mold material is great and consequently the technician has a wide range of choice. Simplest is plaster of paris which is easy to work with and economical, but is heavy, fragile, and deteriorates in appearance with time. Acrylic plastics like Lucite and Plexiglas can be press molded. Polystyrene plastics can be cast molded. Specific brands that have been successfully used in this work are Selectron, Polymer, and Castolite. Polymer is available at most art supply stores and is used without the addition of a hardener. Several coats are brushed on a clay mold over a period of days. When the desired thickness is reached, the plastic mold can be removed from the clay and needs no polishing. Castolite is a clear liquid plastic which hardens with the addition of a catalyst. It can be cast in molds and, when hard, is clear and can be sawed or drilled. Details of mold making can be found in any good handbook of ceramics or plastic crafts.

Certain objects because of their great size require special treatment. It is usually impractical for the small museum to

attempt to treat such objects as totem poles, house timbers, or dugout canoes by any of the methods discussed above. This does not mean that steps to preserve the object cannot be taken. The simplest and most economical procedure is to remove the specimen from the earth or water, bracing it so that it will not be damaged in the moving with a sling or with wooden frames. Once it has been photographed and measured, cover it with a heap of earth which will allow it to dry gradually and will prohibit warping. After a year, the earth is removed and the object is left in the air to become further acclimated. The specimen can be treated with an insecticide and fungicide. The surface is sealed with a solution of sodium silicate diluted in distilled water. For obvious reasons the specimen should not be brought indoors until it is thoroughly dry. As previously suggested, large objects can be impregnated with Carbowax or white glue. The vat needed for big objects can be made by excavating a trench large enough to accommodate the specimen. The trench is lined with plastic water-barrier film. The object is supported on the bottom by blocks and is weighted down below the level of the preservative. Indoors, a frame can be built that will support the plastic sheeting.

Other items of special interest are basketry, barkcloth, and birchbark. They suffer from the same sources of decay as do other wooden objects. Basketry can be treated by the removal of fungus followed by fumigation, spraying, or immersion to kill insects. Pliability is restored by impregnation with beeswax dissolved in benzene. Buffing the wax restores some of the luster. Barkcloth items are fumigated for fungus and insect control, strengthened by couching on flexible plastic sheeting, and improved in appearance by spraying with Krylon. Barkcloth should not be folded because the fibers may collapse at the folds. The natural pliability of birchbark is often restored when it is kept under proper humidity. Surface appearance can be improved by spraying with celluloid in acetone or with Krylon.

CHAPTER VII

TEXTILES

Textile includes woven articles and the fibers of which they are made. Textiles are rarely encountered archaeologically. When they are found there is some preservative agent in their environment. The chief hazard to buried textiles is warm, damp soil where bacteria and fungi can grow. A musty, dark storage compartment is the laboratory counterpart of warm, damp earth. A wide variety of micro-organisms attacks textiles. Some are destructive of animal fibers alone, others only of vegetable fibers, and some of both. Mildew does not harm wool because it lives on the nonfibrous parts, but it causes cotton to deteriorate quickly. The use of the techniques outlined below will prohibit further attacks by decay organisms and insects (Plenderleith 1956: 93 Geiger 1961: 161-164).

Natural conditions that promote textile preservation are arid climate and salt or humic acid in fairly high concentrations. The four areas of the earth where large amounts of textiles are recovered all have very dry climates. Manmade conditions in damp climates include copper and iron artifacts used as mortuary offerings. These oxidize and the resulting oxides preserve the textile. This accidental preservation is not common. Cupric oxide usually stains the textile a characteristic green: iron oxide commonly replaces the fibers, leaving only the texture of the textile.

Freshly excavated textiles are always very fragile. Damp specimens tend to disintegrate on drying. For this reason an in situ photograph and description are mandatory. Much can be learned from a good field photograph if the textile does not survive removal. Metallic oxides will attach the textile to the artifact that has preserved it. A detailed study of the textile should be made before any attempt to study the preserving artifact.

A second study of the textile should be made at the laboratory. Surface soil is removed with a bellows or blowball and camel's hair brush, or with a vacuum cleaner. A piece of screen should be placed over the textile to protect it from the cleaner attachment (The Textile Museum: 1956). The features that should be investigated in the preliminary laboratory study are (Plenderleith 1956: 94):

I. Nature of raw material
   A. Animal
   B. Vegetable

II. Manufacture of textile
   A. Fiber or cord
   B. Nature of twist of cord, S twist or Z twist
   C. Type of weave
   D. Count of warp and weft per centimeter or inch
   E. Presence of selvages

III. Alterations of basic material
   A. Stitching present
   B. Decoration present—description

Animal fibers are shiny in appearance and break with smooth ends. Vegetable fibers are usually lusterless and break with ragged ends. Breakage characteristics are studied by unravelling a single thread of the textile and viewing it under a 10 power hand lens or microscope. Burning a small amount of textile can lead to more positive identification. Most animal fibers burn with a small sizzling flame and give an odor similar to that of burning hair. The ash is usually irregular and brittle. Silk burns like most animal fibers. Its odor is similar to that of burning feathers and it leaves a small black bead. Animal fibers will not smoulder. Vegetable fibers burn with a yellow flame of fair intensity and smoulder with a creeping ember. Their odor is comparable to that of burning paper. The ash is fluffy in texture and gray in color (Anonymous 1945).

The fibers that constitute a textile are divided into warp and weft elements. These elements are composed either of a single spun fiber or of several such fibers twisted together to form thread or cord. The term ply is used to enumerate the number of spun fibers making up the thread or cord. A two-ply thread consists of two spun fibers twisted together: a three-ply thread has three, etc. The direction of the twist of the ply is described as "S twist" if it is twisted to the right, as "Z twist" if it is twisted to the left.

Warp, wale, and shed refer to the fixed elements through which the weft, woof, or filler is passed. The warp fixed, the weft movable, in the weaving process.

The more common types of weaves are plain or tabby, twilled, plaited, braided, and looped. Plain, or tabby, weave is

made by passing one weft element over one warp element, under the next warp element, over the next and so on. Twill weave is recognized by the diagonal rib pattern produced by carrying the weft elements over and under two or more warp elements at a time. Plaited textiles have one end of the yarn attached at a single point or along a plane, the free ends intertwined downward. Braided textiles are characterized by each yarn's passing diagonally over and under the others either from one side or the other, or around each piece. In twine plaiting the yarns are interlinked with each other and twisted together from the top to the bottom of the piece. Looped fabrics are made up of interlocking loops. This is also called "knotless netting" because the technique is identical save that the threads are looped through the mesh rather than knotted. Knitting and crocheting are forms of the looping technique. Selvages are elements introduced to prevent ravelling at the edge of the fabric (Kent 1957; Osborne & Osborne 1954: 1095-1099); Denny 1953).

When the preliminary study is complete, the specimen can be cleaned, strengthened, and preserved. Some surface dirt can be removed by using a blowball or bellows and a camel's hair brush, removing as much soil as possible before the specimen is wet. Wrinkled, folded, or crumpled material can be straightened by spreading a sheet of damp unbleached muslin on top of it. When the textile has soaked up moisture from the muslin it can be straightened, then placed under a sheet of glass to dry. A second straightening technique is lightly to mist the fabric with water and then to dry it under glass as Van Stan does (Florida State University).

If the material is relatively strong, it can be washed or dry cleaned. Wet cleaning is usually preferable. Before washing or cleaning, a small portion of the fabric is spot tested for fastness. Dyes that run are fixed with a bath of 5% salt or 20% acetic acid. The salt bath is used on vegetable fibers, the acetic acid on animal fibers. With proper caution even rather fragile materials can be washed. The safest method for washing is to line a shallow tray with a sheet of thin plastic film held in place by clothes pins attached along the sides of the tray. A wetting agent or a detergent like Vel or Fab is used sparingly to loosen trapped soil. The textile is placed in a tray liner for support. After soaking, the fabric may be tapped gently with the fingers to loosen more trapped soil. Soft water should be used, luke warm for vegetable fibers

and cool for animal fibers. Washing is followed by a thorough rinse. The textile is then laid out flat and blotted with absorbent towels or flannel. When about half dry, turn it over and blot it on the reverse side. After this blotting, the warp and weft are arranged at right angles and the fabric pinned down to lumite or to some other heavy porous material. During drying the pins may need readjustment to avoid damaging the shrinking material. Very heavy materials can be cleaned using the foam method described in Chapter VIII. Spotting agents or bleaches may be used to remove more stubborn stains. Spotting agents may have adverse effects on dyes and for this reason a small sample of each of the colors should be tested.

Here is a list of several good chemical solvents that can be used to dissolve various stains and spots.

Acetic acid, 28% is used to neutralize alkalis, to restore color that has been damaged by alkali, and as a general spotting agent. At room temperature it may be used safely on all fabrics.

Acetone is a solvent for stains from oils, resins, paints, and varnishes. It is highly flammable and dissolves some basic dyes.

Ammonia evaporates completely and leaves no residue to damage the fabric. It may be used to restore color that has been affected by an acid, and is also valuable for its emulsifying properties. Though it may cause yellowing in silk or wool, this condition may be remedied by neutralizing with 28% acetic acid.

Benzol is a solvent for rubber, oils, sulphur, and paint stains and is safe on all fabrics and dyestuffs.

Carbon disulfide is a solvent for road oil, sulphur, rubber, and pitch stains. It is safe on all fabrics and dyestuffs. Its main disadvantages are high flammability and toxicity.

Carbon tetrachloride is used as a general dry spotting agent for oil and grease stains. Safe for all fabrics and dyestuffs, it is toxic if used over a period of time.

Paraffin oil (mineral oil) is a dressing. On dark fabrics it is very effective in covering chafed areas that have been caused by excessive mechanical action in spotting and in wear. It is safe for all fabrics and dyestuffs.

Perchlorethylene (tetrachlorethylene) can be used as a generaly spotting agent for oils and greases but is somewhat explosive. It is safe on all fabrics and dyestuffs.

Water is, of course, the most effective solvent because more different substances are soluble in it than in any other liquid.

Spotting tools are a spatula and brush. To avoid spreading the warp and weft, the brush is dabbed gently on the fabric. The spot is attacked from the reverse side so that the stain is forced out of the material, not through it. Wax is removed by sandwiching the textile between sheets of blotting paper. A hot iron is placed over the spot to liquify the wax which is absorbed by the blotter. A wax residue can be dissolved with benzol according to Samuel Townsend (North Carolina Hall of History).

The original color and brightness of fabrics can partially be restored by bleaching. One should exercise great care in bleaching. Bleaches act either as oxidizing or as reducing agents. These tend to neutralize the effects of each other. If a reducing bleach causes a discoloration it can be rectified by a bath in oxidizing bleach, and vice versa. Hydrogen peroxide and sodium perborate are safe to use on all fibers, while other oxidizing bleaches such as potassium permanganate and sodium hypochlorite are restricted to vegetable fibers. Principal reducing bleaches are sodium bisulfite and sodium hydrosufite. The former is safe to use on all fibers while the latter is used only on vegetable fibers. Bleaching normally has a deleterious effect on old textiles, but carefully used it is very handy for brightening ethnological collections (Anonymous 1939a, 1939b, 1939c, 1944).

Anhydrous solvents or dry cleaners may weaken the fibers and fade the dyes of old textiles. Dry cleaning should be used when wet cleaning must be avoided. The standard solvents are stainless petroleum distillates. They are flammable, yet ordinarily safe to use. Ordinary paste soap is added to the cleaning solvent to increase cleaning power. If soap is used, the textile requires a thorough rinse in the solvent (Rice 1964: 83-90). The standard mixture of soap and solvent is 1 part soap per 4 parts solvent and 1 part soft water. Except for acetic acid and ammonia, the spotting agents listed above can be used as dry cleaning solvents. A spot test is always necessary before any textile is subjected to any solvent. The following solvents are recommended: Varsol, Humble Oil Co.; Shelsol, Shell Oil Company; AMSCO #140, American Mineral Spirits Company; Associated Naphtha #21, Associated Service Corporation; or any other anhydrous non-staining solvent used by commercial cleaning establishments (Textile Museum 1956).

Mounting for display or storage is the next consideration in handling textiles. The clean and dry object can be attached to unbleached muslin, silk, silk net, or plastic netting. Stitching is the best method of attachment. Netting is preferable to muslin or silk because the reverse of the fabric can be studied through the netting. Each stitch should cover one warp so that the weft elements hide the stitch. Using modern synthetic fibers for the stitching prevents confusion with fibers belonging to the original material. The napped surface of velvet will prevent fragile textiles from sliding when displayed. Textiles should never be glued to a backing. Glue may both damage the article and serve as food for insects. Weakened textiles can be strengthened by rinsing in a solution of gum arabic and alum. The gum arabic strengthens the fabric and the alum helps to preserve the color.

Store textiles in clear plastic envelopes in drawer cabinets with brass fittings. The drawers should be large enough to make folding unnecessary. Light materials can be stored on cardboard rollers. If it is necessary to fold a textile, the folds should be backed with pattern paper to prevent creasing. Avoid white tissue paper—residual bleach in the paper may attack the textile. Stored textiles should not be stacked on one another because the weight can break down or further weaken the fibers. Costumes and whole garments can be hung on coathangers. They should be individually enclosed in sealed plastic garment bags.

The storage environment can have adverse effects on textiles. Light, air, and heat in excess are harmful. Light tends to fade all colors. Textile exhibits should not be permanent. Excessive heat dries textiles and causes them to become brittle. Too much moisture promotes fungus growth. High amounts of sulphur dioxide that characterize the air in urban areas can cause rotting if textiles are stored in cabinets with steel pins or steel fittings. The textiles are attacked by the sulphuric acid resulting from the reaction of sulphur dioxide and iron. Ideal storage conditions are cool, dark, and dry.

If ideal climatic control is possible, fungus cannot appear. Insects are not a hazard under proper storage conditions. Moth balls or moth flakes in storage drawers and in the bottoms of garment bags are the best control of clothes moths. The crystals should be replenished periodcially. Impregnation with silicofluoride salts or DDT by adding them to the cleaning solvent offers

a great measure of protection (Anonymous 1948). Spot spraying with insecticides available in aerosol containers offers immediate emergency control.

CHAPTER VIII

SKINS

Animal skins form a more or less uniform sheet of tissue that becomes flexible and durable when processed by one of several methods. A skin is fertile ground for the growth of micro-organisms and for the attacks of insects. If not saved from these fates, it will become dry, stiff, and of little use to man. Possibly, processing animal skins was one of man's first achievements. The first processing probably amounted to no more than scraping and manipulation. The Eskimo method is one of the most simple known and consists of scraping away the flesh and then of twisting and chewing the skin until it becomes flexible.

Tanning is subjecting dehaired, defatted, neutralized skin to a process that renders it non-rotting and somewhat waterproof. Tanning agents are of mineral and of vegetable origins. Vegetable agents are older than mineral tannins. The Breton *tann* means oak, and the bark of the oak has served as a tanning agent for centuries. The ancient Egyptians used acacia pods as tanning agents. The use of chromium salts is modern.

Tannins react with the protein fibers and glue factors that are found in all animal skins by replacing loosely bound water molecules. This chemical change produces leather, which is superior to rawhide in durability, water-resistance, and "feel." Metallically tanned leathers are more durable than leathers produced with vegetable agents, but have a lower working quality than vegetable agent leathers.

Oil tanned leathers (chamois skin, chamois leather) are produced by treating the inner layer of hide with oil after it has been separated from the tough exterior layer. This product is soft, pliable, durable, and not subject to deterioration from wetting. One of its principal uses is the removal of water from freshly painted surfaces to avoid water spots.

Rawhide and buckskin are terms designating skins that have been dehaired, scraped, stretched, dried, and made flexible by manipulation and rubbing in animal grease or brains. Tawed skins are manufactured by rubbing an excess of alum into the skin during processing and restoring the flexibility by twisting. Tawed skins are lighter in color than unprocessed skins because they absorb the whiteness of the alum. They have the qualities of

leather except that they are waterproof. Tawed leather is commonly used in the manufacture of gloves, jackets, and, to some extent, book bindings. If tawed leather is washed, the alum lost in the washing must be replaced by sponding the article with an alum solution. Softness can be restored by manual working after the specimen has dried (Gaussen 1950: 2960).

Sinew, the tough tendons that connect muscle to bone, is used by many preliterate people for cordage. Gut is used for containers and for such clothing as the waterproof suits of the Eskimos (Plenderleith 1956: 19-26).

Items of animal skin are rarely present in archaeological investigations but may occur under conditions of extreme dryness (arid caves of the Southwest) or total immersion in water (wells like those at Jamestown, Virginia or Fort Frederica National Monument). Skin is occasionally preserved when it is buried in contact with copper (DeJarnette, Kurjack, and Keel, in press). Soil moisture usually reduces skin products to a dark humic stain. Low humidity over a prolonged period reduces items of this nature to a black sirupy liquid or to a black solid mass resembling ebonite (Plenderleith 1956: 26). Controlled humidity is the best way to preserve skin products. Low humidity is a cause of deterioration: extremely high humidity encourages the growth of fungi. The ideal climate for the storage of leather and skin goods is 50% relative humidity at 70°F. Although conditions may warrant the use of fungicides, such treatment should not be considered final in the preservation of skin products. It will not correct the conditions allowing the attacks of the fungi. Once correct climatic conditions have been achieved, certain items infected with fungus growths may be treated in a very weak solution of paranitrophenol or parachlorophenol. The paranitrophenol solution should not exceed a .35% strength and the parachlorophenol solution should not be stronger than .025%. Commercial products such an Santobrite are used in a 2% solution for items that can be impregnated (Nopitsch 1950: 3606; Plenderleith 1956: 27-28).

The deterioration of vegetable-tanned leather bookbindings poses a serious problem. Once the chemical reaction that causes this rotting has begun, nothing can be done to stop its progress. This phenomenon is caused by the reaction of sulphur dioxide in the air with certain iron compounds in vegetable-tanned leathers to form sulphur trioxide, which in turn reacts with water to form sulphuric acid. The acid causes the leather to dry and to

crumble. The application of a leather dressing will slow up this process, but nothing will stop it. Leathers tanned with chromium salts will not react with atmospheric sulphur dioxide because the iron compounds have been stabilized during the tanning process. Although chrome-tanned leathers do not have the fine workable qualities of vegetable-tanned leathers, they are more permanent and are presently preferred to the finer vegetable-tanned leathers (Plenderleith 1956: 25-26).

Washing leathers is harmful because the water removes soluble salts which are preservative factors. If washing is necessary, the best products are saddle soap or a good grade of castile soap used with cool water. Surface dirt should be brushed away prior to washing with a soft brush. Allowing the washed leather to dry at room temperature before applying a 10% solution of potassium lactate which replaces any water soluble salts lost in the washing process. The solution is made by dissolving 2 oz. of potassium lactate in 1 pint of distilled water (Plenderleith 1956: 357).

The foam method of cleaning leather is preferable to the method outlined above. Make a heavy lather from a mild detergent (Vel, Fab, or Sail) by placing a large quantity of the detergent in a small amount of warm water and beating it with an electric mixer or by repeatedly squeezing the solution through a sponge. Apply the foam to the article, let soak for a few minutes, then wipe with absorbent paper or cloth. The foam may be applied several times for better results, but the specimen should not be allowed to become overly wet—valuable preservatives may be lost. The principal value of the foam method is that soil is carried away in suspension and the specimen does not become completely soaked (O'Flaherty 1954: 29).

The final step in treating leather goods consists of applying a light coat of leather dressing and thoroughly working it into the leather for added protection.

Attacks by various insects pose a great hazard to collections of skin products. Infested leather items may be impregnated with a non-staining insecticide with a colorless paraffin base. If impregnation is undesirable because of the presence of fugitive paints or for any other reason, the following procedure is recommended.

Place the item to be treated in an airtight box or container with dichlorobenzine crystals for about a month. Do not allow

the specimen to come in contact with the crystals. The crystals may be placed at the bottom of the container and covered with a perforated piece of cardboard, or they may be placed in a small perforated tin can.

The use of leather dressings is a universal preserving technique. There are many varieties of leather dressings and many institutions have their own preferred formula. White vaseline, lanolin, and neat's-foot oil are the more common ingredients of leather dressings and may individually be used as dressings. Neat's-foot oil is a widely known dressing, but has been known under certain conditions to acidify and "burn" articles to which it has been applied. On the other hand, white vaseline and lanolin offer the same protection and do not hazard damaging the article. Burns (1941: 123-124) offers several dressing compounds. The following have been selected because they do not contain ingredients which might be harmful to the specimen:

1.	Lanolin, anhydrous	30 parts
	Castor oil	12 parts
	Japan wax, pure	5 parts
	Sodium stearate, powdered	3 parts
	Water, distilled	50 parts
2.	Lanolin, anhydrous	55 parts
	Sperm oil, pure 20° cold test	35 parts
	Japan wax, pure	10 parts
	Sodium stearate, powdered	5 parts

Leather dressing in small quantities should be carefully worked into small areas of the specimen. Several thin coats applied at daily intervals are preferable to one thick coat which offers less protection and often leaves a sticky, dust-catching residue of unabsorbed dressing. Since dressing will darken the specimen it should be applied from the reverse side. One light coat is usually sufficient for items designed to be stiff (scabbards and helmets), and for items with worked or tooled surfaces. The application of a microcrystalline wax such as Griffin Neutral Wax or a thin lacquer coating will help preserve the specimen and will restore its appearance.

One can unfold aged dry leather or skin without damage by applying leather dressing and water to the folds until they become soft and pliable. The specimen can be carefully unfolded and worked back into its original shape. It should then be treated *in toto* with leather dressing (Burns 1941: 123-124).

Ethnological specimens of rawhide or buckskin can be treated for preservation in the same manner outlined for tanned items. Objects like drumheads and parfleches are often decorated with fugitive paints and the application of a dressing will ruin these decorations. Treat such specimens with extreme care, applying only small quantities of leather dressing. It is often more practical to replace split drumheads with new ones but, if something makes replacement impractical or undesirable, the split drumhead can be preserved in the following manner.

Dampen the specimen with a sponge filled with water until it becomes flexible, then remove it from the drum. Any grease present on the drumhead must be removed before it can be repaired. This can be done by application of benzene or trichloroethylene, taking care to remove only the grease or oil. The specimen is next placed on a suitable backing (linen, light canvas, or another thin piece of leather), and cemented to the backing with a water-soluble glue such as flour paste, Flexbond, or Rubbarez. In remounting the drumhead, use only enough tension to keep the specimen flat.

Fur is one of the most perishable materials of the many products derived from animal coats. It is highly susceptible to attack by insects, particularly to those of the orders *Coleoptera* (beetles) and *Heterocera* (moths). Furs require constant inspection and should be hung up under conditions unfavorable to insects. The best climate for the storage of furs is about 40°F with a relative humidity of 50%. The flesh side of furs can be treated with leather dressing to restore softness and pliability. Dressings containing neat's-foot oil and olive oil should not be used for furs: they may acidify and burn the hair. If insect infestation is present there are several common procedures for treatment. Isolated attacks on one or a few fur specimens can be controlled by direct spraying with a good insecticide dissolved in a clear petroleum distillate. Many commercial insecticides on the market will serve. A periodic change in insecticides is recommended because insects are known to build up resistance to a particular poison over a protracted period of time. Arsenical soap may be rubbed into furs but boric acid or borax will give the same protection and neither is toxic to man or domestic animals. Furs sprayed with powdered insecticides should be laid flat and a pressure of at least 30 pounds per square inch used to spray the powder. Cellophane or plastic bags with a handful of moth crys-

tals in the bottom make excellent storage containers. The moth crystals, as long as they are not completely sublimated, will protect the fur from insects. A new supply of crystals should be added periodically. It is worthwhile to repeat that constant inspection of furs is paramount to their preservation. Cases of widespread infestation are best solved through fumigation by licensed exterminators.

Hair, in itself, is one of the most stable animal products; however, because of the presence of oil or fats it is subject to insect attack. The easiest way to preserve hair is to clean it thoroughly and to keep it clean. Castile soap and cool running water are the best cleansing agents. After the washed hair has dried, a small amount of lanolin or vaseline worked in thoroughly will restore its softness and luster. Infested hair can be treated in the same manner as fur. Scalplocks, for example, should be cleaned, the scalp portion treated with leather dressing, the hair with lanolin (Burns 1941: 155; Leachman 1931: 144; Gaussen 1950: 2962).

Excavated skin and leather, if wet when uncovered, should be kept so until they can be treated. It is advisable to store the wet materials immediately in a 2% aqueous solution of carbolic acid. The acid stops bacterial action and continued moisture prevents shrinkage. The second step is to immerse the specimen in molten vaseline. The heat will drive out much of the moisture, which will be replaced by the liquified vaseline. The replacement will prevent some shrinkage. After 24 hours in the molten vaseline the specimen is transferred to a solution of molten paraffin and kept at a temperature of 80° to 110° for 1 to 2 days. When removed from the paraffin the specimen can be stretched to its original shape or stuffed with soft paper to control further shrinkage (Burns 1941: 124).

Lashings or cordage of sinew become brittle when dry. They should be moistened with water before any attempt is made to tighten or to retie them. It is advisable to hold lashings in place with a dab of celluloid glue rather than to attempt to retie them. Once secured, the lashing can be painted with celluloid varnish. Sinew is subject to insect attack and should be checked periodically. Insects can be controlled and eradicated by local application of a non-staining insecticide (Leachman 1931: 147).

Specimens of gut are treated with small amounts of lanolin, vaseline, or leather dressing applied on small areas at a time and

thoroughly worked in. These substances, if carefully applied, insure maximum absorption without a greasy appearance.

CHAPTER IX

REGISTRATION AND STORAGE

The primary objective of registration is to provide a means for identifying the specimens in the collection. This is done by cataloguing the specimens. It is common in museum practice to speak of the accession number and the catalog number in regard to a given specimen. The accession number refers to one or to many specimens that constitute a part of the collection. It is understood that all objects having the same accession number have something in common. This common trait may or may not have cultural significance. Several objects may be given the same accession number because they were collected from the same archaeological site or a group of objects may share the same accession number because they were donated to the institution by an individual who collected them over a period of years from all over the world.

The catalog number, on the other hand, denotes cultural significance. It is given to a particular object or to a group of objects because of its cultural provenience. Most museum handbooks discuss methods for establishing accession catalogues and specimen catalogues. Recently Stephan Borhegyi and Alice Marriot (1956: 77-86) have made a plea for the standardization of accessioning practices among museums. Such grand schemes would greatly improve the usefulness of collections to investigators if carried out. However, for sundry reasons it is likely that such a plan will never be accomplished.

It is sufficient here to say that all systems of identification should have certain minimum characteristics. These, it would seem, should include:

1. Date collected or received
2. Source of acquisition
3. Location
4. Description

The first three requirements are brief; the fourth somewhat longer. The description should be plain enough to identify the particular specimen to the exclusion of all others. In the case of the archaeological specimens which may have the same catalog number this requirement need not cause discomfort. The analysis of the materials will point out the specimen under consideration or will at least narrow the field down to a classificatory division.

Ethnological specimens require more description. They are generally complete artifacts as opposed to archaeological specimens which usually are fragments of wholes.

The length of a description will depend on the particular artifact and on the peculiarities of the system in use. The description should be as brief as possible but should include size, color, material, function, name, any design or marks described or sketched, and other significant characteristics.

Measurements are important for identification and for estimating space requirements for storage. Most measurements can be made with a ruler or tape and calipers. Record the measurements in a uniform manner, i.e. height, width, depth or length and/or thickness, or height and diameter. In the case of composite objects such as a bowl and lid, both individual and overall measurements are normally taken.

Color can best be described by using a standard chart (Munsell 1942); however, a suitable substitute is a fresh box of pastel crayons such as Alphacolor. One can note gradations between different pastels.

Correct identification of materials is essential for description. A knowledge of mineralogy, metals, botany, and zoology is important. Type collections of minerals, plants, animals, bone, etc. sufficient for competent identification are normally beyond the facilities of the archaeological laboratory or university museum. In both instances, however, the anthropologist should know specialists who can help with particular problems. If a substance cannot be satisfactorily identified, its physical properties can be described, for example, "hard, dark green stone" or "porous gray stone," or "very hard close-grained dark brown wood."

The most commonly encountered minerals in archaeological collections include quartz, jasper, and serpentine. The archaeologist is likely to encounter the following rocks: basalt, diorite, pumice, slate, sandstone, limestone, gneiss, schist, quartzite, and marble. Many stones appear similar but can be distinguished from one another by several tests including relative hardness, structure, chemical composition, and specific gravity. The term, flint, is used to cover a wide variety of stone—jasper, chalcedony, chert, and other crystalline stones. Alabaster is often confused with limestone but can be distinguished from it by the application of acid. Limestone, marble, calcite, and chalk are calcium

carbonates and react readily with any acid. Alabaster and gypsum are calcium sulfates and do not effervesce when acid is applied. Hardness is usually defined in terms of the Mohs' Scale. Materials harder than 6.5 (a steel file) are infrequently found in archaeological or ethnological work.

The method of manufacture is an obvious part of the description of specimens. Stone artifacts are chipped, ground, drilled, pecked, or polished. Pottery is molded, thrown, modeled, coiled, or paddled. Wooden artifacts are burned, abraded, carved, or cut. Textiles have particular kinds of weaves. Artifacts of metal are cast, welded, annealed, or forged. Bone is split, abraded, polished, or perforated. Shell may be cut, polished, drilled, and engraved.

Specialists in other fields will be needed for the identification of specific materials in many instances. Fortunately, such specialists are usually only too glad to assist the anthropologist.

Marking Specimens

The actual writing of the assigned catalog number on the specimens may be an odious chore to some: to others it produces a familiarity with the specimen that is evidenced in analytical work.

Temporary marks used for identication prior to actual cataloguing can be made on paper stickers, tags, or tape. These methods *are* temporary—stickers will become unglued and lost, tags will be torn off, tape will dry out and be difficult to remove.

Ideally, permanent catalog numbers are clear and easily located. It is good practice to locate the number in the same place on each general group of specimens. Heavy objects should be marked near the base rather than on the bottom. Mark potsherds on the interior surface, textiles on linen tape sewed to the specimen, basketry on the interior near the orifice.

Marking mediums include india ink, artist's oil paints, fine and medium pen points, and fine artist's brushes. The numbers should be clear. Some objects require a background of one color or a colored ink. Personal experience will guide decisions in marking methods. I prefer black india ink for ceramics, bone, stone, shell, antler, and metal. A crow-quill pen does well in marking stone and metal, and a fine nibbed pen point will not cut into specimens of bone, shell, or ceramic material. If the specimen is dark, substitute white lacquer paint for the black ink. If the

object is porous and the ink blotches, paint the area reserved for the number with a solution of Gelva and acetone. When this dries, the number goes on quite neatly. The number is protected by a coat of the Gelva solution.

Storage

Storage is one of the most pressing problems in the laboratory or museum. Space for storage is usually at a premium. Proper storage is necessary for the preservation of all organic specimens. The ideal conditions of storage of organic materials have been outlined in the chapters dealing with each general class. It is most important that organic materials receive periodic inspection to insure their conservation. Objects of fur, skin, feathers, wood, and textiles can be quickly destroyed by an unobserved insect invasion. The ideal conditions of storage for perishable objects consist of proper temperature and humidity control.

The storage of non-perishable or inorganic materials depends on the physical setup of the institution and on the personal attitudes of the anthropologist. Some prefer to store materials according to the units in which they were recovered—all specimens, regardless of the raw material, coming from a given unit are stored together. The reason most often given for this procedure is that one does not have to chase all over looking for the specimens from a given unit. This is a valid reason but the procedure results in space problems. Only loose units of storage can be used because all units of provenience are not equal in size.

Other anthropologists prefer to store specimens according to both cultural and material considerations—all chipped stone in one place, all bone in another, all ceramics in yet another, and so on. This system is satisfactory in that physical space can be used more practically and economically. Such a system does seem to result in a better mode of identification and cataloguing. In either case storage should be under dry, dust-free, dirt-free conditions.

CHAPTER X

INSECT CONTROL

Once cleaned and preserved, perishable specimens may be destroyed by the attacks of insects. Such attacks can and frequently do occur in the storage areas of large, well-staffed museums where the collections are well maintained. Since insect destruction happens, so to speak, in the "best of all possible worlds," it certainly is more prevalent in small, under-staffed institutions.

Textiles, skins, fur, and feathers are subject to attacks from moths and beetles who use them as food. Even wood-eating termites can cause damage to the objects if they are stored in contact with unprotected wood.

In addition to moths, beetles, and termites, the common insect pests that attack museum collections include roaches, silverfish, crickets, and several species of ants. Many institutions control these insects by contractual agreements with exterminating firms. The Orkin-franchised companies and others offer a year by year contract that includes total fumigation, periodic checks, and treatments, if needed. Rates vary according to the size of the collection and the frequency of inspection desired by the contracting institution. I strongly recommend securing such service, particularly if the collection is extensive.

Steps can be taken in storing items to guard against destructive agents. All objects should be stored clean. Storage should be such that unpacking for inspection is not a chore and does not produce conditions favorable to the insects.

Specific steps for moth-proofing textiles have been mentioned. It is much better to protect these items with moth proofing as they are cleaned than to find at a subsequent time that they have been damaged by insect pests. Steps in the control of insect attack on objects of wood have already been considered. Furs can be protected by rubbing them with arsenical soap or powdered borax.

The main factors in the control of insects are frequent inspection, immediate treatment if infestation is discovered, and renewed inspection at even more regular and frequent intervals.

A vast array of liquid, powder, and mist insecticides is available. They are usually effective in any case of infestation. The

product and method of use will depend largely on the particular specimen. Aerosol bombs are handy for textiles, skins, feathers, furs, bark-cloth, and basketry. Powdered insecticides are equally useful for textiles, skins, furs, and feathers. Liquids or sprays can be used on wooden objects so that they actually impregnate the specimen.

Certain physical treatments can be used but are not generally so effective as chemical controls. Infected specimens may be temporarily sterilized by subjection to vacuum treatment or they may be frozen or heated, taking care that freezing or heating does not cure the disease and kill the patient. In any case, subjection to a vacuum or to extremes in temperature are only temporary measures. They do not give the specimen any protection against new insect infestation.

Research Laboratories of Anthropology
Chapel Hill

BIBLIOGRAPHY

AJPA
1936 Note on the Use of Polymerised Vinylacetate and Related Compounds in the Preservation and Hardening of Bone. *American Journal of Physical Anthropology,* Vol. 21, pp. 449-450. Washington.

Antle, H. R.
1940 Some Points in Bone Preservation. *Notebook.* Society for American Archaeology. Vol. 1, pp. 118-125. Menasha.

Anonymous
1939a Wool Damage in Bleaching. *Bulletin T-75,* National Institute of Cleaning and Dyeing. Silver Spring.
1939b More About Bleaching. *Bulletin T-76,* National Institute of Cleaning and Dyeing. Silver Spring.
1939c Permanganate Vs. Perbolate. *Bulletin T-78,* National Institute of Cleaning and Dyeing. Silver Spring.
1944 Bleaching with Hydrogen Peroxide. *Bulletin T-150,* National Institute of Cleaning and Dyeing. Silver Spring.
1945 Identification of Fibers. *Bulletin T-145,* National Institute of Cleaning and Dyeing. Silver Spring.
1948 Mothproofing. *Bulletin T-193,* National Institute of Cleaning and Dyeing. Silver Spring.
1956 Wool Damage—Its Causes, Determination, and Prevention. *CIBA Review,* Vol. 10, No. 113, pp. 4136-4137. Basle.
1957 Identification of Bast Fibers. *CIBA Review,* Vol. 11, No. 123, p. 33. Basle.

Barghorn, E. S.
1943 Collecting and Preserving Botanical Materials of Archaeological Interest. *American Antiquity,* Vol. 9, No. 3, pp. 280-294. Menasha.

Bentzen, C. B.
1942 An Inexpensive Method of Recovering Skeletal Material for Museum Display. *American Antiquity,* Vol. 8, No. 2, pp. 176-178. Menasha.

Bick, L., E. S. Cripps and D. M. D. Thacker
1954 Some Methods for Protecting Cleaned Iron Objects. *Museums Journal,* Vol. 54, No. 1, pp. 32-36. London.

Borhegyi, Stephan and Alice Marriot
1958 Proposals for a Standardized Museum Accessioning and Classification System. *Curator,* Vol. 1, No. 2, pp. 77-86. New York.

Brenner, Howard
1953 Tarnish-Removing Dips for Silver, Gold, And Copper. *Electroplating and Metal Finishing,* Vol. 6, No. 3, pp. 371-376. Teddington.

Brogger, A. W., H. Falk and H. Schetelig
1959 Burial of a Viking Queen. In *The Archaeologist At Work,* edited by R. F. Heizer. pp. 23-53. Harper and Brothers, New York.

Burns, Ned J.
1941 *Field Manual for Museums,* National Park Service, Washington.

Burr, Nelson R. (Compiler)
1952 *Safeguarding Our Cultural Heritage: A Bibliography on the Protection of Museums, Works of Art, Monuments, Archives, and Libraries, Library of Congress,* Washington.

Byers, Douglas S.
1962 The Restoration and Preservation of Some Objects from

Etowah. *American Antiquity,* Vol. 28, No. 2, pp. 206-216. Salt Lake City.

Caley, Earle R.
1955 Coatings and Incrustations on Lead Objects from the Agora and the Method Used for their Removal. *Studies in Conservation,* Vol. 2, No. 2, pp. 49-54. Aberdeen.

Cann, F. R.
1937 Insect Damage in Timber and Wooden Exhibits in Museums. *Museums Journal,* Vol. 37, No. 6, pp. 281-291. London.

Carswell, T. S., and Ira Hatfield
1939 Pentachlorophenol for Wood Preservation. *Industrial and Engineering Chemistry,* Vol. 31, No. 11, pp. 1431-1435. Washington.

Coleman, Laurance V.
1939 *Manual for Small Museums.* G. P. Putnam's Sons. New York.

Cornwall, I. W.
1956 *Bones for the Archaeologist.* Phoenix House, Ltd. London.

Covington, Clyde H.
1951 *The Spotting Department.* National Institute of Cleaning and Dyeing. Silver Spring.

Crabb, Edward D.
1923 *A Handbook of Preserving Museum Specimens in the Field.* University of Oklahoma Press. Norman.

Creighton, John T.
1957 Household Pests. *Bulletin 156.* Florida Department of Agriculture. Tallahassee.

Dart, Raymond A.
1956 The Cultural Status of the South African Man-Apes. *Smithsonian Report for 1955, pp.* 317-338. Washington.

Deaton, John W.
1962 The Preservation of Wood by the Alum Process. *The Florida Anthropologist,* Vol. 15, No. 4, pp. 115-117. Tallahassee.

DeJarnette, D. L., E. B. Kurjack and B. C. Keel
In Press Archaeological Investigations in the Weiss Reservoir, Cherokee County, Alabama. University of Alabama. University, Alabama.

Denny, Grace D.
1953 *Fabrics.* J. B. Lippincott Co. Chicago.

Deschiens, Robert and Christine Coste
1957 The Protection of Works of Art in Wood from the Attacks of Wood-eating Insects. *Museum,* Vol. 10, No. 1, pp. 56-59. Paris.

Dickens, Roy S.
1964 Report on Preservation of an Indian Canoe at Town Creek Indian Mound, North Carolina. (Unpublished report on file at the Research Laboratories of Anthropology, University of North Carolina at Chapel Hill.)

Dudley, Dorothy H., and Irma Bezold
1958 *Museum Registration Methods.* American Association of Museums. Washington.

Dunton, John V. N.
1964 The Conservation of Excavated Metals in the Small Laboratory. *The Florida Anthropologist,* Vol. 17, No. 2, pp. 37-42. Gainesville.

Gairola, T. R.
1961 Preservation of Wooden Antiquities. *Journal of Indian Museums,* Vol. 7, No. 1, pp. 25-35. Calcutta.

Gaussen, August
1950 Preservation of Skins and Leather. *CIBA Review,* Vol. 7, No.

81, pp. 2960-2962. Basle.

Geijer, A.
1961 The Conservation of Textile Objects. *Museum*, Vol. 14, No. 3, pp. 161-164. Paris.

Gettens, Rutherford J.
1959 *I.I.C. Abstracts*. Vol. 2. Edited by Rutherford J. Gettens. The International Institute for Conservation of Historic and Artistic Works. London.
1960 *I.I.C. Abstracts*. Vol. 3. Edited by Rutherford J. Gettens. The International Institute for Conservation of Historic and Artistic Works. London.
1964 The Corrosion Products of Metal Antiquities. *Annual Report of the Smithsonian Institution, 1963*. pp. 547-568.

Greathouse, Glen A. and Carl J. Wessel
1954 *Deterioration of Materials, Causes and Preventative Techniques*. Reinhold Publishing Corp. New York.

Heizer, Robert F.
1958 *A Guide To Archaeological Field Methods*. Third Revised Edition. The National Press. Palo Alto.

Holmes, William H.
1884 Prehistoric Textile Remains of the United States. *Third Annual Report of the Bureau of Ethnology*. Washington.

Jedrzejewska, Hanna
1964 The Conservation of Ancient Bronzes. *Studies in Conservation*. Vol. 9, No. 1, pp. 23-31. Aberdeen.

Johnson, E. N.
1941 Preservation and Cleaning of Shell Material. *Notebook*. Society for American Archaeology. Menasha.

Kent, Kate P.
1957 The Cultivation and Weaving of Cotton in the Prehistoric Southwestern United States. *Transactions of the American Philosophical Society*. Vol. 47, Part 3. Philadelphia.

Larson, Lewis H., Jr.
1954 Georgia Historical Commission Excavations at Etowah, Summer 1954. *Early Georgia*, Vol. 1, No. 3, pp. 18-22. Athens.

Laudermilk, J. D.
1937 The Preservation of Textile Remains. *American Antiquity*, Vol. 2, No. 3, pp. 277-281. Menasha.

Leachman, Douglas
1931 Technical Methods in the Preservation of Anthropological Specimens. *National Museum of Canada Annual Report for 1929*. pp. 127-158. Toronto.

Linton, George E. and Joseph J. Pizzuto
1948 *Applied Textiles*. 4th Edition. Lifetime Editions Inc. New York.

Munsell, A. H.
1942 *Munsell Book of Color*. 2 Vols. Pocket Editions. Baltimore.

Museums Association
1954 *Handbook for Museums*. Museums Association. London.

Nichols, Henry W.
1930 Restoration of Ancient Bronzes and Cure of Malignant Patina. *Field Museum of Natural History Museum Technique Series No. 3*. Chicago.

Nopitsch, Moritz
1953 Preventive Treatments for Textiles and Leather. *CIBA Review*. Vol. 9, No. 100, pp. 3606-3609. Basle.

O'Flaherty, F.
1954 Leather and Its Care. *Leather Manufacturer*, Vol. 71, No. 3. London.

Organ, R. M.
1953 Use of Ion-exchange Resins in the Treatment of Lead Objects. *Museums Journal*, Vol. 53, No. 1, pp. 49-52. London.

Osborne, Douglas and Carolyn Osborne
1954 Twines and Terminologies. *American Anthropologist*, Vol. 56, pp. 1093-1100. Menasha.

Parmalee, Paul
1963 Prehistoric Porcupine in Alabama. *Journal of of Alabama Archaeology*, Vol. 9, No. 2, pp. 88-89. University, Alabama.

Pelikan, J. B.
1964 The Use of Polyphosphate Complexes in the Preservation of Iron and Steel Objects. *Studies in Conservation*, Vol. 9, No. 2, pp. 59-66. Aberdeen.

Plenderleith, H. J.
1956 *The Conservation of Antiquities and Works of Art.* Oxford University Press. London.

Plenderleith, H. J. and R. M. Organ
1953 The Decay and Conservation of Museum Objects of Tin. *Studies in Conservation*, Vol. 1, No. 2, pp. 63-72. Aberdeen.

Prichard, M. E.
1954 *A Short Dictionary of Weaving.* George Allen and Unwin, Ltd. London.

Printup, Dan
1961 A Method of Pottery Restoration. *The Tennessee Archaeologist.* Vol. 17, No. 1, pp. 10-14. Knoxville.

Randall, C. B.
1940 *The Dry Cleaning Department.* National Institute of Cleaning. Silver Spring.

Rawlings, F. I. G.
1954 Science in the Care of Museum Objects. *Museums Journal.* Vol. 54, No. 2, pp. 263-264. London.

Rees-Jones, Stephan
1957 *I.I.C. Abstracts*, Vol. I. Edited by Stephan Rees-Jones. International Institution for Conservation of Historic and Artistic Works. London.
1963 A Simple Vacuum Impregnation Tank for Pottery and Other Objects. *Studies In Conservation.* Vol. 8, No. 2, pp. 67-71. Aberdeen.

Rice, James W.
1964 A Drycleaning Method for Textile Conservation. *Studies in Conservation.* Vol. 9, No. 3, pp. 83-90. Aberdeen.

Rohner, John
1961 A Method of Reconstructing Pottery. *Museums Graphic.* Vol. 13, No. 1, pp. 10-11. Missouri State Museum. St. Louis.

Rosen, David
1941 The Preservation of Wood Sculpture: The Wax Immersion Method. *The Journal of the Walters Art Gallery*, Vol. 4, pp. 123-127. Baltimore.

Seborg, R. M. and R. B. Invenarity
1962 Conservation of 200-year-old Water-logged Boats With Polyethylene Glycol. *Studies in Conservation.* Vol. 7, No. 4, pp. 11-12. Aberdeen.

Shepard, Anna O.
1957 *Ceramics for the Archaeologist.* Carnegie Institution of Washington. Washington.

Sills, B. and S. Corezyn
1958 The Embedding of Cleared Biologic Specimens. *Curator*, Vol. 1, No. 2, pp. 87-91. New York.

South, Stanley A.
1962 A Method of Cleaning Iron Artifacts. *Newsletter*, Southeastern Archaeological Conference. Vol. 9, No. 1. Pp. 17-18. Cambridge.

Swift, W. H.
1959 *Special Notice to Museum Curators*. W. H. Swift Associates. Dunellen.

The Textile Museum
1956 Principles of Practical Cleaning for Old and Fragile Textiles. *Workshop Notes*, No. 14. Washington.

Torrey, Howard
1940 Pottery Restoration. *Notebook*, Society for American Archaeology, Vol. 1, No. 3, pp. 136-138. Menasha.

UNESCO
1955 The Care of Wooden Panels. *Museum*, Vol. 8, No. 3. Paris.

Vogt, E.
1947 Basketry and Woven Fabrics. *CIBA Review*, Vol, 4, No. 42, pp. 1938-1945. Basle.

Wiertelak, J. and J. Czarnecki
1935 Paraffin-Impregnated Wood. *Industrial and Engineering Chemistry*. Vol. 27, No. 3, pp. 543-547. Easton.

Wolff, Eldon G.
1939 Pottery Reconstruction at the Milwaukee Public Museum. *Notebook*. Society for American Archaeology, Vol. 1, No. 2, pp. 53-61. Menasha.
1960 Pottery Restoration. *Curator*, Vol. 3, No. 1, pp. 75-87. New York.