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# CHAPTER 5

## ARCHIVAL AND CURATORIAL METHODS

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### 5.1 BASIC PRINCIPLES

Collectors often do not give enough thought to the preservation of their shell and fossil collections. A shell is a hard, durable item, or so we think. Unfortunately, that shells are hard durable items is not the case. Many forces are conspiring to destroy our collections. If we want our collections to maintain maximum longevity, we must apply basic principles of good curation (Solem *et al.* 1981, Rose and de Torres 1992, Rose *et al.* 1995). Applying these principles will not only help preserve our collections but will also make it easier to incorporate them into a museum's collection. They will also help to maximize the value of a collection if it is to be sold.

The first principle of good curation is to do no harm. Whatever else, do not treat or handle a specimen in a way that makes it worth less after curation than it was worth before. One should strive to apply treatments that can be reversed easily. For example, it is better to use an adhesive that can be easily removed as opposed to one that will defy the use of a hammer and chisel to remove it.

The second principle dictates that techniques should be used that cause as little permanent change to a specimen as possible. It should be assumed that whatever we do to a specimen will cause some change, and sometimes the change may not be completely reversible. Thus, we should minimize what the permanent change to the specimen will be. An example of this is the way some people preserve the periostracum of naiads (Unionidae) with a paraffin/xylene solution. The shell is dipped in the solution and the xylene then evaporates. Paraffin is left behind and this helps to preserve the periostracum from drying out and flaking off. If one wants to remove the paraffin, successively soaking the shell in xylene will leach the paraffin out. However, in addition to the paraffin, other xylene soluble substances will also be removed. This will cause a permanent change to the shell. If morphometric studies of the shell are the objective of a study, then the paraffin/xylene treatment will be of no consequence. However, if we wish to undertake some biochemical studies of the shell, the effects of the treatment will be of importance. One way out of this dilemma would be to treat some but not all of the shells, and record which ones were treated.

The third of the basic principles is to record what techniques you apply to a specimen, and to record them on the specimen's label. In this way, others will be able to tell what was done to a given specimen, whether it can be undone, and what effect it will have on future analyses that might be applied to the specimen.

Techniques that follow these principles will be discussed in this chapter. Sources for many of the products mentioned in the next few pages are listed in the appendix at the end of the chapter.

### 5.2 DANGERS TO A COLLECTION

I would like to address six basic dangers to collections. They include risks that result from acid exposure, temperature, humidity, light, pests, and shock/abrasion. There are other dangers such as flooding, storms and other natural disasters, fire, theft, and being exposed to armed conflicts, but these catastrophic dangers are beyond the scope of this chapter.

The first aim should be to avoid exposing a collection to these dangers. If avoidance has not been done consistently then you have to fall to a second line of defense, which is to detect incipient problems and block their subsequent damage. Least satisfactory is detecting damage that has already occurred and trying to stop further degradation. Rarely can one reverse damage that has already occurred.

**5.2.1 Acid, temperature, and humidity.** The first three dangers, acid, temperature, and humidity (often measured as relative humidity, RH) all contribute to a condition called Bynesian Decay (also called Bynes Disease) (Tennent and Baird 1985, Shelton 1996). The calcium carbonate of the shell decomposes in this condition. Bynesian Decay was thought to be due, in part, to a process initiated by bacteria, but is now known to be a chemical process. Bynes originally investigated this process and published papers on it between the years 1899 to 1907. Since it is a chemical process and not a bacterial one, I advocate the term decay as opposed to the older designation as a disease.

This condition can affect collections large and small. Sometimes a few shells are affected, occasionally whole collections. Once the decay has started, the part of a specimen that has been affected cannot be restored. However, further deterioration can be halted.

For Bynesian Decay to occur, acid must be present in the microenvironment of the shell. The acids most commonly involved are formic and acetic acids. These acids are produced by the wood used in cabinets, cardboard trays and boxes, and labels, as well as from the adhesives used in the construction of cabinets and in the repair of specimens. Along with the acidic fumes, temperature is also a concern. The higher the temperature the faster acids can react with the calcium carbonate of the specimens and change it into calcium acetate-formate salts. Thus, at lower temperatures, Bynesian Decay will progress more slowly. Lastly, the humidity must be high enough to provide moisture for the acids to dissolve and precipitate out onto the specimens to cause the decay.

Thus, we see that Bynesian Decay is due to the misfortune of several conditions being present to allow this process to occur. As mentioned above, wood can be a source of the acids. Some woods are more acidic than others and the acidic woods should be avoided when constructing cabinets. The worst offender is oak. Some of the better woods are spruce, mahogany, walnut, birch, basswood, poplar, and balsa. If the woods being used are veneers, then one has to be concerned with the adhesives used in making the veneers and whether they will offgas acidic fumes, as well as the type of wood underneath the veneer.

Plywoods are often constructed using urethane adhesives which can offgas formaldehyde, an acidic compound. If plywood has to be used, one designed for exterior use is preferred. The adhesives used are less harmful than those used in interior plywoods, and the offgasing problem is less intense. Particleboard and pressed wood should be avoided because of the adhesives used in their production (Hatchfield 1995).

The ideal cabinet construction is a metal cabinet that is painted using a powder coat process. Here the metal is painted by a process of electrostatically coating the surface with pulverized polymers (the paint) and then fusing it to the metal with heat. There will be no offgasing of organic solvents or other substances. Two manufacturers of such cabinets are Lane Scientific Equipment Corp. and Steel Fixture Manufacturing Co.

R. Tucker Abbott described how to build a wooden cabinet (Abbott 1954). He recommended a standard size cabinet 40 inch high (101 cm), 22 inch (56 cm) wide, and 32 inch (81 cm) deep. Runners for the drawers should be 30 inch long and set 2-$^1/_4$ inch apart. The internal dimensions of the drawers were 20 x 30 x 1-$^5/_8$ inch. The door should be hinged so that a drawer can be pulled out when the door is open only 90 degrees, and an additional feature is a door that can be completely lifted off its hinge.

If a wooden cabinet is being painted, water based paints and varnishes are preferred. Oil based products can give off formaldehyde and other volatile organic compounds (VOC). These can contribute to Bynesian Decay. Allow four weeks for the cabinet to completely air out and offgas before putting specimens into it. Remember, other sources of acids are the paper you use in the labels and trays, and the inks you use. These will be addressed later.

Temperature is a concern in storing a collection. At higher temperatures, chemical reactions occur faster, thus the decay process will be more likely to occur at a higher than at a lower temperature. In addition, offgasing of acid vapors is faster at a higher temperature. An additional complication is that the items that we are trying to preserve have different ideal temperatures for storage. The ideal temperature for storing photographic images will differ from that for books and papers, which will be different from that for shells. Thus, there is no easy answer to the question, "What is the best temperature to maintain a room that houses a mixed collection?" In general, for shells, a temperature in the range of 16-21ºC (60-70ºF) appears to be a good compromise between the needs of the collection and a reasonable working environment for people.

Relative humidity is the amount of moisture in the atmosphere at a given temperature relative to how much the air could possibly hold at that temperature. As temperature increases, the atmosphere can hold more water and therefore dissolve more acidic gases. That is the reason that humidity is of such concern in collection management. Fluctuations in humidity can also be problematic. Mineral specimens such as shales, clays, and amber can crack and flake if the humidity gets too low. Some shells, such as the gastropod genus *Paryphanta* and the bivalve genus *Pyganodon* will get too dry at low humidity and crack or shatter. Paper products may become brittle at low humidity. Inks may flake off the page and book covers may warp at high humidity levels.

You might have the occasion to collect fossils that are composed of Pyrite. Pyrite will start degrading at elevated humidity and give off acidic gases. This condition is called Pyrite Disease (or more recently Marcasite Disease), though as in the above discussion on Bynesian Decay, it is not a bacterial disease. I prefer the term Pyrite Decay (Marcasite Disease has not yet gained widespread use). In Pyrite Decay, iron sulfide combines with oxygen and water and forms iron sulfates and sulfuric acid. The result is that the integrity of the specimens is destroyed. If any calcium carbonate shells are present, the sulfuric acid can precipitate Bynesian Decay.

Many techniques have been proposed for preventing Pyrite Decay. Their basis is to prevent the specimen from coming in contact with air either by encasing the specimen with an artificial resin or submerging it in a liquid such as glycerin, paraffin oil, kerosene, or silicone oil. None of these techniques work well (Howie 1992).

The best prevention is to maintain the pyrite specimens in a low relative humidity, around 30% (Howie 1992, Waller 1992). If some degradation has already occurred, neutralization of the degradation products with ethanolamine thioglycollate may help (Cornish and Doyle 1984). Some researchers advocate placing specimens in an oxygen free environment (anoxic environment). This technique is beyond the scope of this chapter but you can read about it in Burke (1996).

There are causes of variation in temperature and RH that we may not even think of. If a cabinet sits in sunlight for part of the day, it may experience fluctuations in temperature and RH on a daily basis. If a cabinet is against a sun-exposed outside wall, it may experience fluctuations that are not seen in other cabinets against inside walls. Basements and lower floors of a building tend to be more humid. Thus, some people recommend that collections are better stored on the upper levels of buildings.

For the above diversity of problems, universal recommendations are difficult to come by. For a collection of a given type of specimens and storage conditions, you may find several different recommendations of temperature and RH. In general, if the relative humidity of a shell collection is maintained within the range of 50-55%, one should not be concerned. This, with a temperature range of 16-21ºC (60-70ºF) is well within the abilities of home heating/ventilation/air conditioning systems and may need only occasional help from a dehumidifier. The best way to monitor the RH is with a wet-dry bulb thermometer or a hygrometer. I use a mechanical Abbeon Model HTAB 169B hygrometer/thermometer combination while the Section of Invertebrate Zoology at the Carnegie Museum uses a battery operated Oakton Digital Maximum/Minimum Thermohygrometer. I like the fact that I do not have to worry about the battery running out; they like the recording capability of the battery operated device. Hygrometers cost $35-200 depending on the sophistication and accuracy one seeks in the instrument; the Abbeon is approximately $150 while the Oakton is approximately $40.

There are also devices called dataloggers. These are small devices that can cost from $100 to $1000. They are electronic devices that take multiple measurements of temperature and relative humidity; every few minutes, every few hours, or daily. The data are stored on a microchip within the datalogger. You then download the information to a computer and can graph out the results. Some dataloggers contain a readout so that you can see what the current measurements are. Dataloggers may also have alarms to alert you when preset parameters have been exceeded. Most dataloggers will run for at least a year on a set of batteries. Arenstein (2002) provided more information on dataloggers including general datalogger features, comparative data for fourteen models, and addresses for manufactures of these devices. Dataloggers can be purchased from several of the suppliers listed at the end of this chapter.

**5.2.2 Light.** Light provides energy for chemical reactions to occur. If we limit exposure to light, we can slow down these chemical processes. The type of light is also important. While visible light can cause problems, ultraviolet light (UV) is more problematic. UV light has more energy than visible light and, therefore, it causes more damage than visible light. Fluorescent lights give off more ultraviolet radiation than do incandescent bulbs.

Light causes several problems in natural history collections (Weintraub and Wolf 1995:194). Exposure to visible and ultraviolet light can cause specimens to fade. Non-archival inks will fade on exposure to light. Sunlight and incandescent bulbs may cause an increase in temperature and variations in RH. Short-term exposure should not be problematic. If fluorescent lights are on for a long period of time, UV filter tubes should be placed around the bulbs. If there is a large amount of sunlight in the room, UV filters can be placed on the windows. Neither of these types of products causes noticeable changes in light intensity. They do need to be changed periodically as they lose their filtering ability. Replacement, which is dependent upon the intensity of light exposure, should not be necessary more than every 5-10 years.

**5.2.3 Pests.** Pests may cause many problems. Silverfish and cockroaches can eat the adhesives that are used in bookbindings. They can also eat the paper used in labels and books. Mice and rodents can also chew up paper materials. Mold will grow on paper and even on some porous specimens making removal difficult or impossible. Prevention is better than treatment. Mold and most insects will be kept under control at the levels of temperature and RH recommended above. If vermin are a problem, mechanical traps are useful. In regards to insecticides, not much is known on how their components will affect a collection. Pyrethrums or permethrin should afford the safest alternative among the insecticides. A powder form is preferred, as it would not contain the solvents and other volatile organic compounds found in an aerosol spray. Consult the paper by Jessup (1995) for more details on pest management.

**5.2.4 Shock and abrasion.** Shock and abrasion can also wreak havoc on a collection. Specimens can be dropped, crushed, or abraded. They can be crammed together in tight spaces. The headroom above a drawer may be insufficient and the drawer above it may hit the specimen. Specimens can abrade labels and make them difficult to read. There are several ways to decrease damage due to shock and abrasion.

Foam liners in specimen trays can be effective. The foam must be archival and polyethylene foam is commonly used (the archival nature of plastics is discussed below). Avoid polyurethane foam (foam rubber). It is not archival and it will degrade over time giving off acidic vapors (formaldehyde). Labels can be placed in polyethylene tetraphthalate (Mylar®) or polyethylene bags or sleeves. This prevents them from being abraded by the specimen and also decreases contact between specimens and acidic labels. Specimens should not be placed in a tray that is too small. The tray should be big enough to allow space around each of the specimens in a lot. One can use a standup label. This allows all the pertinent information on the label to be read without having to handle the specimen. One can view the specimen and read the label with minimal handling of either. Drawers should slide smoothly to minimize jostling. Lastly, one can fill all empty spaces in a drawer with empty trays. This prevents trays with specimens from sliding around when a drawer is moved.

A collection should be organized in a manner that minimizes the handling of specimens. By arranging a collection systematically according to some system (e.g. Thiele 1929-1935, Vaught 1989, Thiele 1992-1998, Millard 2003), a specimen can be located without shuffling through the whole collection. In arranging a fossil collection, one would store specimens using a combination of stratigraphic and systematic criteria.

If a collection includes any type material, these should be segregated from the research collection. By segregation, I mean that they should not be with the regular collection, but stored in a separate drawer or cabinet. Type specimens are specimens that were used by someone in describing a new genus or species. Type specimens are discussed more fully in Chapter 10.5.2.

In some collections, other classes of specimens will also be segregated from the main reference collection. Non-type material that might be segregated includes rare, threatened, endangered, or recently extinct species. Figured specimens, sometimes known as hypotypes, are specimens used for the purpose of illustration in a scientific publication. These specimens are also segregated in some collections. This allows them an additional degree of protection from excessive handling. Topotypes, material from the same locality as the name bearing types but not used in the original description are sometimes segregated into the type collection.

## 5.3 PAPER

Paper is used to construct trays and make labels and collection catalogs. The paper used should be archival. There are several points to consider when selecting paper products. The first is that they should be acid free. Acids will cause paper to yellow, become brittle, and decompose. These effects are due to acids breaking down the bonds between cellulose fibers leading to a loss of integrity of the paper. Second, paper should be low in lignin content. Lignin can break down to form acids that can in turn cause the paper to disintegrate. Most papers made from wood pulp are high in lignin while those made from cotton or linen are low in lignin. A third consideration is a paper that is buffered. This means that the manufacturer adds a chemical to the paper that will help to neutralize acids. Calcium carbonate is the most common buffer used. Lastly, the paper should be alkaline sized and not acid-rosin sized.

These points suggest that the optimal paper would be one with a pH of 7-8, a lignin content less than 0.3%, buffered with 2-3% calcium carbonate, and alkaline sized. When buying paper, look for paper for which the manufacturer is willing to supply full specifications. There are also indicator pens made that will determine the pH or lignin values of paper. These work best on white or light colored paper. For example, using a pH indicator pen, you would make a mark on the paper in question and the color that the mark turns indicates the approximate pH of the paper. The Section of Invertebrate Zoology at the Carnegie Museum uses Mohawk Superfine, 65 pound, smooth white paper. The malacology groups at the Natural History Museum of Los Angeles County and the Delaware Museum of Natural History use Perma/Dur paper, which can be obtained from University Products, while the Section of Mollusks at the Carnegie Museum uses Permalife Bond Writing Paper, a 20 pound 25% cotton, acid free, archival paper from Fox River Paper Co. For more information on cellulose based papers see Burgess (1995).

There is also paper made from Tyvek®, a form of polypropylene. This product is virtually indestructible. It does have several drawbacks. Inks tend to bleed on Tyvek® and it does not accept pencil markings as well as cellulose based paper. In addition, it cannot be used with a laser printer, as it will melt. Teslin® is another polymer based paper that has been developed. Like Tyvek®, it is waterproof and quite resistant to wear and tear. Some forms of it seem to work well with ink jet and laser printers. How well it will stand up as an archival product has not yet been determined.

## 5.4 INKS AND COMPUTER PRINTERS

Most of us give very little thought to the inks that we use. They are, however, complex chemical mixtures and their compositions are often proprietary secrets. Inks are mixtures of pigments, dyes, binders, and vehicles. Dyes stain the paper fibers, while pigments settle out on the fibers. India inks are pigment type inks that use carbon black as the pigment. Several India inks that have been found to be relatively stable and are considered archival are Rotring 17 Black, Hunt Speedball Super Black Ink, Pelikan 17 Black, Higgins T-100, and Pelikan 50 Special Black (Williams and Hawks 1986). In addition, some brands of disposable pens are considered archival. They are convenient to use and come in various point widths. Two brands that fall into this category are Pigma and ZIG.

There are three main types of computer printers: dot matrix, ink jet, and laser. Dot matrix printers are generally considered archival (depending on the ink). The ribbon is coated with a carbon pigment and is applied to the paper by impact. If the pigment is worn away, the impact of the print may still be read on the label by oblique illumination. Ink jet printers should be avoided. The inks used in these printers are rarely archival and often are soluble in water and organic solvents. This solubility prevents them from being used in wet collections. In addition, the inks tend to fade on exposure to light.

Some laser printers may be used for archival purposes. Mainframe laser printers apply ink and then set it with heat and pressure. This process appears to give an archival result. Desktop laser printers do not use the same amount of heat and pressure, and thus the result is not archival. Because of the heat involved, Tyvek® paper should not be used with laser printers.

Another printing method that is gaining popularity in museums is one using thermal transfer printing. Two different methods are used. In direct thermal printing, the printing is burned into the medium, a plastic material such as polyester. The second method, thermal wax transfer, uses heat to melt the ink which is then applied to the medium, paper or plastic. The labels hold up well in ethanol and thus are well suited for wet collections. These printers will print down to a 4 point font size. The limiting factor is cost. These printing systems cost around $1,300. Bentley (2004) discusses these methods in greater detail.

Photostatic or xerographic printing is also a cause for some concern. Some of these inks are not archival, some are not solvent resistant, and flaking of the print can be problematic. Since one frequently does not know the particulars of the ink, paper, and process involved with these methods of printing, I cannot recommend them as being archival. One should not print labels or documents this way unless you can obtain assurance from the manufacturer of your equipment that it uses an archival process.

Recently, CD-ROM's have been used to publish books. With the advent of writable and rewritable CD-ROM's, some collectors have been storing their collection catalogs in this format. Not all CD-ROM's are archival. There have been improvements in long-term stability and some are rated at life spans of 25-100 years if stored at 25ºC (77ºF). If you plan to use a digital format for long-term storage, make sure you are using an archival product and store it under archival ranges of temperature and RH. It is advisable to have a printed copy for backup (see below).

## 5.5 VIALS AND JARS

Vials and jars are used for holding small specimens or in storing material in a wet collection. Generally, glass is used because of its stability and clarity. Borosilicate glass, such as Pyrex, Kimax, and Wheaton 800 are brands to look for. Flint glass (soda-lime glass) is a less desirable form of glass, as it is more likely to degrade over time. Using ultraviolet light, one can identify the type of glass. Under ultraviolet light, flint glass fluoresces a bright yellow-green color (Simmons 1995).

**5.5.1 Glass decay.** I would like to discuss the inherent weaknesses of flint (soda-lime) glass and a condition known as Glass Disease. As with Bynesian Decay, Glass Disease is not a disease but a decay process that affects glass so a more appropriate term might be Glass Decay. Glass tends to be thought of as a relatively stable and inert substance; however, under certain conditions this is not true, especially for soda-lime glass.

Glass Decay is a deterioration of glass that is exposed to water and carbon dioxide. Non-silicate elements of the glass, such as sodium oxide, leach out, react with water vapor, and form alkaline solutions. Over time, the glass weakens and a white powder deposits on the glass.

The chemical reaction appears to be one of sodium oxide in the glass reacting with water in the air and forming sodium hydroxide. The sodium hydroxide reacts with carbon dioxide to form sodium carbonates. This reaction seems to be able to occur at RH's as low as 20%, but more commonly at a RH of 40% or higher.

Note, that this process requires water (moisture) in order to develop. Also recall that chemical reactions occur at faster rates at higher temperatures than at lower temperatures. Therefore, the same controls to prevent Bynesian Decay should also prevent or slow down the development of Glass Decay: keeping a low relative humidity and temperature in the collection storage area.

A similar reaction occurs in potash glass; potassium oxide reacts with water to form potassium hydroxide. This in turn reacts with carbon dioxide and results in the formation of potassium carbonate. The result is that the soda-lime and potash glass crazes, cracks, and develops a frosted appearance over time. The resulting container is weakened.

Since Glass Decay results in basic chemicals being formed (not acidic chemicals), it does not cause the same risks to a collection as seen in Bynesian Decay. Most specimens stored in glass vials are small. If the glass container turns from a clear one to a frosted one, specimens will have to be removed more frequently to be viewed. This causes risks from physical handling to these smaller, more fragile specimens. Also, the salts formed in Glass Decay can precipitate out on the specimens making fine details hard to view.

If the process of decay occurs only on the surface (a process more common with glass manufactured in recent centuries) the process that occurs is called devitrification. This surface process occurs on account of recent soda-lime glass being more stable than those of previous times.

Besides controlling storage conditions, you can also consider using borosilicate glass. Borosilicate glass is preferable to soda glass. While more expensive, it appears to be a more stable form of glass, and is less susceptible to the processes of Glass Decay and devitrification. See Hamilton (1998) for more on issues involving glass and its conservation.

**5.5.2 Vials, jars, and closures.** When closing vials there are several options. Cork should be avoided as an option; it tends to be acidic and decomposes over time. It also exposes the collection to acidic vapors. A second option is cotton. This tends to be acceptable if a high quality grade of cotton is used. Cheaper grades of cotton may be acidic. Before using cotton, test its pH with a pH-testing pen. The use of polyester fiber or batting is becoming more common. It is cheaper than cotton and just as easy to work with. Lastly, some vials come with polyethylene or polypropylene snap caps. These are archival, but more costly than using polyester fiber.

When it comes to sealing jars, there is a combination of a lid and a liner. There are several different lids and liners available. The first type of lid, and one of the poorer choices, is made from a plastic called Bakelite®. Bakelite is usually a black plastic that is very rigid. It often comes with a cardboard liner that is foil coated. This type of lid is not considered archival on three accounts. First, the lids tend to crack if over tightened. Second, they are susceptible to backing off, a process where a lid loosens due to fluctuations in temperature or exposure to vibration. Lastly, the cardboard liner absorbs fluid that causes it to swell and deteriorate over time.

A second type of lid is a metal lid, with or without a liner. Metal lids tend to rust, and in the presence of glycerin or formaldehyde, they tend to corrode rapidly. These chemicals are frequently found in wet collections. For these reasons, metal lids are generally unacceptable.

Polypropylene lids with polyethylene liners are an excellent combination. The softer polyethylene molds to the irregularities of the jar opening and the polypropylene lid can be tightened without undue fear of cracking. If one is planning to maintain a small wet collection, it may be easier to contact a university or museum with a malacology collection to see if you can obtain a few jars and closures from them.

A final option is a bail top jar or Mason jar. These tend to work well but have some drawbacks. The lids snug down nicely with the wire snap; however, the rubber gaskets tend to deteriorate over time and need to be changed periodically. While some gaskets seem to be more resistant than others, they can be difficult to track down or purchase in small quantities. Thus, the main drawbacks of these jars are their cost, the difficulty in finding them, and the difficulty in finding or replacing the gaskets. If you acquire a few of these jars, a museum or university may have appropriate sized gaskets.

When storing tissue in fluid (wet collection), ethanol is the best all around preservative. A concentration of 80-90% should be used. Specific recommendations for preservation of soft tissues are made in the taxonomic chapters, in Chapter 14, and below in Section 5.9.

Many collectors are using archival plastic boxes and polyethylene ziplock bags for storing dry specimens. These containers have several advantages. They tend to be less expensive than glass vials, have good clarity, and come in a large range of sizes. They also help to control the microenvironment surrounding the specimen. The types of plastics used in their manufacture are considered archival and are discussed in the next section.

## 5.6 PLASTICS

I have mentioned the use of plastics at several points in this chapter. Some plastics are considered archival while others are not. In general, one wants to use plastics that have no or low levels of plasticizers. The fewer UV inhibitors and dyes that are put into the plastic the better. Lastly, one wants a plastic that is free of surface coatings. With these considerations in mind, there are five plastics that are considered to be archival. They are polyethylene, polypropylene, polycarbonate, polyethylene tetraphthalate, and polytetrafluoroethylene (Teflon®). There is some question of the long-term stability of polystyrene. Some people feel that as long as you avoid exposing it to organic solvents, there should be few problems using polystyrene. Other curators and collection managers suggest avoiding it completely. If you chose to use polystyrene, I recommend that you periodically check the specimens stored in these containers. Polyvinylchloride and polyurethane should be avoided as they can degrade and give off acidic vapors.

Some people like to reuse plastic containers that originally had some other use, for example, margarine tubs or 35mm film containers. The question is how to decide if they are made out of archival plastics. This has become quite easy with the advent of recycling. Plastic products that can be recycled have a code on them. The code is either a triangle with a number in it, an abbreviation of the plastic's name or both. This is generally located on the bottom of the container. Table 5.1 shows the code and which products are archival. Again, watch for possible contamination from colors added to the plastic or the product being coated with other substances. Note that polycarbonate and polytetra-

**Table 5.1 Recyclable plastics.**

| Number | Abbreviation | Plastic | Archival |
|---|---|---|---|
| 1 | PETE | Polyethylene tetraphthalate Polyester, Dacron®, Mylar® | Yes |
| 2 | HDPE | High density polyethylene | Yes |
| 3 | PVC | Polyvinyl chloride | No |
| 4 | LDPE | Low density polyethylene | Yes |
| 5 | PP | Polypropylene | Yes |
| 6 | PS | Polystyrene | Uncertain |
| 7 | Others | Other plastics | No |

fluoroethylene are not recyclable plastics and thus do not appear in the chart.

Williams *et al.* (1998) discussed a sequence of tests that are useful in distinguishing twelve clear plastics. Their algorithm includes polyethylene, polypropylene, polystyrene, polycarbonate, and polyethylene tetraphthalate.

## 5.7 CONSOLIDANTS AND ADHESIVES

I will begin with some definitions. An adhesive is a substance used to bind items together. Glues are adhesives that are derived from animal origins; for example, rabbit hide glue. A consolidant is a substance used to permeate and strengthen a specimen. Just because a glue or consolidant was described as being useful in the past literature, do not assume that it is still an appropriate substance to use. Shellac was once widely used, but it is no longer considered an acceptable consolidant. With adhesives and consolidants, reversibility is an important consideration. We should be able to undo what we did, with minimal effect on the specimen. Along with reversibility, a non-acidic nature and dimensional stability are also important and desired attributes.

Among the adhesives and consolidants that are considered to be safe and archival are polyvinyl butyral (Butvar 76 and Butvar 98), polyvinyl acetate (Vinac), and acrylic copolymer (Lucite, Acryloid B72, and Paraloid). My favorite is Butvar 76. It is soluble in acetone and I make a thick mixture by dissolving 2.2 kg (one pound) of Butvar 76 in 4 L (one gallon) of acetone. This mixture is used as an adhesive. I dilute this slurry 1:1 with acetone and use this solution as a consolidant. It has the properties of fast penetration, a non-adhesive finish (non-tacky when dry), a brief drying time, and low toxicity.

If Butvar is applied to a specimen that contains moisture, a white haze will result on the surface of the specimen that was consolidated. Therefore, be sure specimens are dry when using Butvar. The main precaution is to use it with adequate ventilation. The solvent, acetone, can cause respiratory depression. Good ventilation prevents this. Acetone is also flammable and should not be used around an open flame.

Some adhesives and consolidants are no longer considered archival. These should be avoided. This group includes polyvinyl alcohol (shrinkage with age), cellulose nitrate (glyptal), and commercial mixtures. The problem with commercial mixtures (at least those that do not disclose the ingredients) is that one does not know what components are in the mixture. Also, without any warning, the manufacturer can reformulate the mixture.

You should also realize that some people avoid adhesives completely. They do not glue pieces of a specimen back together unless there is a specific reason to do so. They just put the pieces in a polyethylene bag and store them that way. This avoids any possible contamination to the specimen. If a specimen needs to be repaired in the future, a decision can be made then as to the best method to use. For further information on adhesives and consolidants see Elder *et al.* (1997).

## 5.8 RECORDS

A complementary activity to using archival methods is maintaining adequate records for the collection. There are several aspects of record keeping of which the collector should be made aware. The first point concerns the data that accompanies the specimen. All data should be connected with a specimen in an unambiguous manner (see Chapter 14). The second point is that a catalog should be kept. A hardbound, lined journal is a good choice. These can be purchased at most office supply stores. The data for each lot of shells is recorded on one line. In addition, this information should be on a label that is stored with the specimen(s). Many collectors are maintaining their catalogs digitally. If this is done, frequent backups should be undertaken, and the software that allows the catalog database to be read should also be backed up. This prevents data from being lost if the computer crashes, or a floppy disc or CD-ROM becomes corrupted and unreadable (it happens!).

Computer databases are excellent for searching the records of a collection. However, one must make sure that the data can be accessed now and in the future. Whether a database that is stored and not used for ten or twenty years will remain accessible is uncertain because of rapid technological changes. How many collectors still have a computer capable of reading a 5-$^{1}/_{4}$ inch floppy disc? On account of these uncertainties, some collectors are continuing to maintain a paper-based catalog along with their digital one.

Such a paper-based catalog can be a journal as mentioned above or a printout of the digital catalog. If one chooses the printout version, it should be printed on acid free paper and eventually bound. This will protect the data and prevent pages from becoming lost. This also allows the collection to remain useful if the digital form becomes corrupted or unreadable. For more information on databases, see Chapter 8.

How to label or identify a shell is a matter of personal preference. Most museums place the catalog number directly on the specimen with an archival India ink. If the shell is porous or friable, the number can be written on a small strip of paper and glued to the shell. Another alternative is to treat the surface of the shell with a consolidant, painting over this with an opaque paint, and write the number on this surface. One such product, called Liquid Label™, is available from Light Impressions. You paint on the opaque layer and let it dry. You then write your number on it and paint over it with the acrylic copolymer. If you wish to remove the number, just wash off the Liquid Label™ with acetone. If the shells are small, they may be put in a vial or plastic bag along with a slip of paper with the catalog number recorded on it. This can also be done with larger shells if one does not wish to write numbers on them.

Some collectors will measure a shell to the nearest millimeter or tenth of a millimeter, recording the size and the data in a ledger. The size can be used as the means of identifying the specimen. This works well if there are only one or a few specimens of a given taxon in a lot or collection. This method becomes impractical if there are tens or hundreds of specimens of a given taxon.

Do not use codes for recording localities and other data. Even if you have a key to decipher the code, it may get lost. Write the information out in full. I have worked with a collection donated to the Carnegie Museum where much of the locality data was recorded in code. For many of the specimens, the code could not be deciphered. When a key was finally found, a number of the codes were not on it. Consequently, these specimens have been stripped of their scientific value.

## 5.9 WET COLLECTIONS

Sometimes you may find it necessary to preserve mollusks that do not have a shell. You may find a need to preserve the soft tissues of a shelled mollusk. For this, ethanol is the best all around preservative. For general purposes an 80% concentration should be used. If the tissue is being saved for DNA studies, then a 95-100% concentration of ethanol should be used. Sometimes an 80% ethanol, 15% water, 5% glycerin solution is used. This allows the tissues to retain some flexibility if the preservative evaporates. If this solution is used, do not use metal lids. As mentioned above, glycerin will accelerate the deterioration of the metal lid.

If the preservative has evaporated and left behind desiccated tissue, you do have some options to reconstitute the tissue. Also, when a bivalve shell dries, the ligament and resilifer become hard and inflexible. These occasionally need to be softened so that the valves can be repositioned. You can accomplish this by one of several methods.

The point must be stressed, unless you need to rehydrate a specimen, do not do so. Rehydrating solutions all have an effect on a specimen and the effect is not always benign (Beccaloni 2001, Simmons 2002: 102-103). If a specimen that was stored in alcohol has dried out, leave it dry. A better method of rehydration may come along in the future. However, if you need a soft specimen again try the following techniques.

You can try soaking the specimen in a 0.5% aqueous solution of trisodium phosphate (Van Cleave and Ross 1947). Thompson *et al.* (1966) used a method that involved soaking the dried specimen in a mixture of 50% ethylene glycol and 50% water. Lastly, you can try an aqueous detergent solution. Presnell and Schreibman (1997: 484) described a method using a 1% aqueous solution of Trend® while Taylor (2003: 8) used a 5% solution of Decon 90®. If the tissue to be re-hydrated is small, you may have to soak it only overnight; larger specimens may require several days.

## 5.10 CONCLUSIONS

Following the above principles will cost more than following non-archival practices. However, I feel that the benefits derived from archival practices far outweigh their additional costs. The basic principles are doing no harm, using archival substances as often as possible, and recording, on its label, what you do to a specimen. Controlling aspects of the collection environment, temperature, humidity, volatile acids, light exposure, pests, and shock/abrasion, will help to preserve a collection for posterity. Following good curatorial and record keeping practices will assure that the scientific integrity of a collection will be preserved. If you develop an interest in archival practices, I strongly recommend that you join the Society for the Preservation of Natural History Collections. This group was created to investigate archival matters and publishes a newsletter, journal, and several books on archival and curatorial practices. For more information go to their web site at <www.spnhc.org>.

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## APPENDIX 5.1

General and archival laboratory suppliers:

**Acme Vial and Glass**
1601 Commerce Way, Paso Robles, CA 93446
<www.acmevial.com>
glass containers

**Althor Products**
PO Box 640, Bethel, CT 06801
<www.thomasregister.com/olc/althor/>
plastic boxes

**Bioquip Products**
17803 LaSalle Ave., Gardena, CA 90248-3602
<www.bioquip.com>
collecting equipment

**Carolina Biological Supply Company**
2700 York Place, Burlington, NC 27215
<www.carolina.com>
general field and laboratory equipment

**Conservation Resources International, Inc.**
8000-H Forbes Place, Springfield, VA 22151
<www.conservationresources.com>
archival supplies

**Fisher Scientific**
585 Alpha Drive, Pittsburgh, PA 15238
<www.fishersci.com>
general laboratory equipment

**Forestry Suppliers**
PO Box 8397, Jackson, MS 39284-8397
<www.forestry-suppliers.com>
field equipment

**Gaylord Bros.**
PO Box 4901, Syracuse, NY 13221-4901
<www.gaylord.com>
archival supplies

**Lane Scientific Equipment Corp.**
225 West 34th Street, New York, NY 10122-1496
<www.lanescience.com>
metal cabinets

**Light Impressions**
PO Box 940, Rochester, NY 14603-0940
<www.lightimpressionsdirect.com>
archival supplies

**Sigma (Chemicals)**
PO Box 14508, St. Louis, MO 63178
<www.sigma-aldrich.com>
chemicals

**Steel Fixture Manufacturing Co.**
PO Box 917, Topeka, KS 66601-0917
<www.steelfixture.com>
steel cabinets

**Thomas Scientific**
PO Box 99, Swedesboro, NJ 08085-0099
<www.thomassci.com>
general laboratory supplies

**University Products, Inc.**
517 Main Street, PO Box 101, Holyoke, MA 01041-0101
<www.universityproducts.com>
archival supplies

**Wheaton Scientific Products**
1501 N. 10th Street, Millville, NJ 08332-2093
<www.wheatonsci.com>
glass containers