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CLEANING GLASS: A MANY-FACETED ISSUE

Stephen P. Koob

Abstract

The removal of decades of cigarette smoke, grease and grime from handling, and more recently, pollution and off-gassing from improper storage cabinets, will contribute significantly to the prolonged stability of all glasses. In addition, glasses that are subjected to prolonged storage in high humidity (over 55% rH) will begin to hydrate and the alkali in the glass is brought to the surface. Unless this is removed, the alkali will eventually start to dissolve the silica in the glass.

There are numerous types of glasses, but the "silica-soda-lime" glasses make up approximately 90% of all types from antiquity to the present, from Roman vessels to modern window panes. These glasses are generally thought to be very stable, but they will slowly deteriorate (through weeping or crizzling) over decades and centuries of prolonged exposure to high humidity, grime and pollution.

Most glasses can be washed using a detergent and water, as long as the glass is sound and in good condition. Warm tap water can be used for the initial washing, followed by rinsing with deionized or distilled water. A dilute conservation-grade detergent is recommended, such as Synperonic A-7 or Triton XL-80N. Cleaners or detergents that contain perfumes or ammonia should be avoided. A simple washing, even once in the lifetime of a glass, will protect the glass for decades, if not centuries. Soft brushes and soft cotton toweling are recommended. Glass objects should never cleaned in a dishwasher, or with abrasive sponges or cleaners.

Introduction

There are many, many reasons to wash glass, the most basic of which is that the glass looks much better when clean (Figs. 1, 2). There are also many instances and situations when one should not clean glass, as in the case of severely weathered archaeological glass, where cleaning will remove the iridescent or opalescent weathering layers (Fig. 3). The primary reason not to remove the weathering on archaeological glass is the fact that glass deteriorates, or corrodes, or "weathers" from the outside in. If the weathering is removed, so is the original surface, including the details, decoration and information preserved in that surface layer (Smith 1999). The end appearance may be a glass with its original color, but since glass does not always corrode evenly, the result will be a glass with a severely pitted and etched surface, whose integrity has been compromised. Unfortunately, every museum and every time period have their own tastes, and until recently it was not unusual for archaeologists and curators to remove the weathering layers from glazed ceramics and glasses. However, this is not an acceptable practice today.

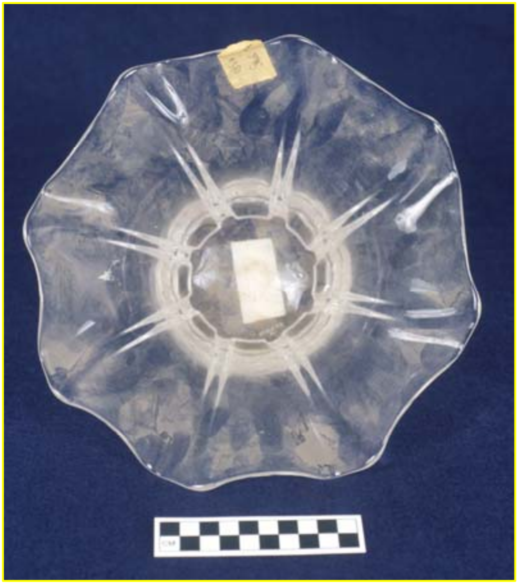

Figure 1. Dirty glass plate with paper label and masking tape (CMOG 59.4.279A).

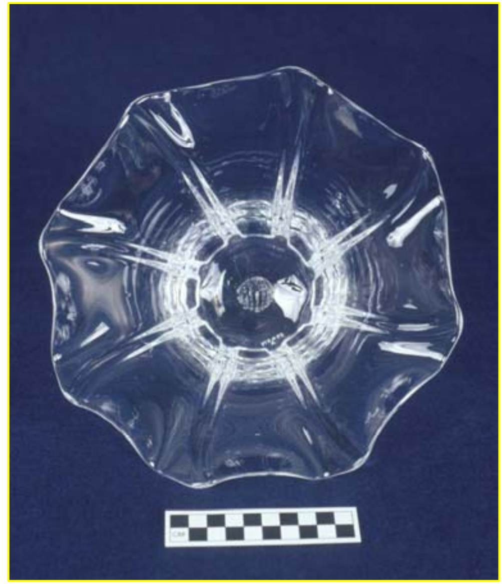

Figure 2. Plate in Fig. 1, after washing.

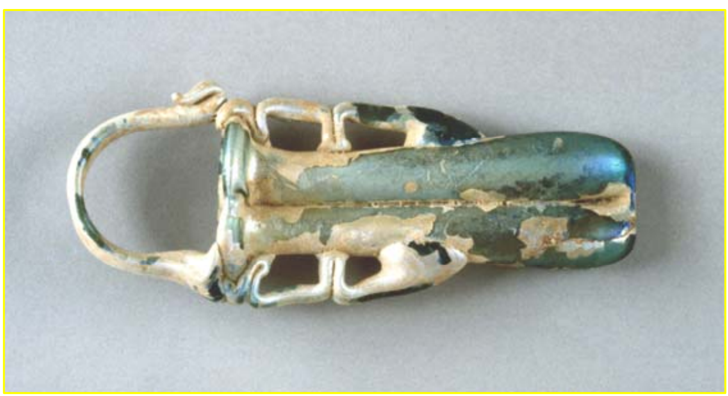

Figure 3. Roman glass unguentarium with flaking weathering. Arthur M. Sackler Gallery, Smithsonian Institution (LTS1985.1.174.24).

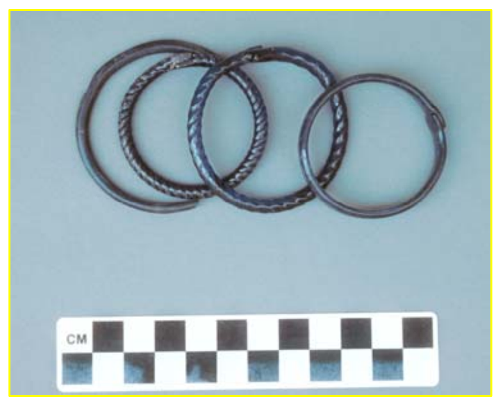

Figure 4. Well-preserved glass bracelets from a 7th century BC tomb at Gordion, Turkey (Gordion Inventory G 162).

Some archaeological glasses do not even need to be washed, or can be safely washed, as they have no weathering, and come out of the ground looking like they were made yesterday (Fig. 4). Some modern studio glasses should never be washed as they have cold painted decoration (applied after the glass was made and cooled) or organic attachments (textiles, fur, wood, etc.). These pieces should be treated as other sensitive composite materials, e.g., ethnographic objects.

Cleaning

The first and most important point in cleaning glass is to know something about the glass. If the glass is sound and in good condition, it generally can be cleaned, or if the glass has been previously cleaned, it can be cleaned again. If there is some doubt, one should learn more about the glass. Most glasses are of a composition that are called silica-soda-lime glasses, with a very stable composition of approximately 70% silica, 20% soda (sodium carbonate, one of the most common alkalis used in the production of glass), and 10% lime (or CaO), which serves as a stabilizer. This composition makes up about 90% of all glasses, and has changed very little from ancient times to modern. Despite the many new types of glass being developed every day, most glasses from Roman times to modern window glasses have virtually the same composition. The glasses are strong, durable and can safely be cleaned.

Additional reasons for cleaning glass include the removal of accumulated dirt and grime, tapes, adhesive labels (see Fig. 1), old or yellowed adhesives or fills (Fig. 5), or to repair the results of a natural disaster (Fig. 6). In addition, almost any glass made before 1980 probably has some traces of cigarette smoke or nicotine on it. Smoking was so commonplace 25 years ago that it was even possible to smoke in most museums.

Figure 5. Yellowed adhesive and fill on a glass sculpture (CMOG 59.4.426).

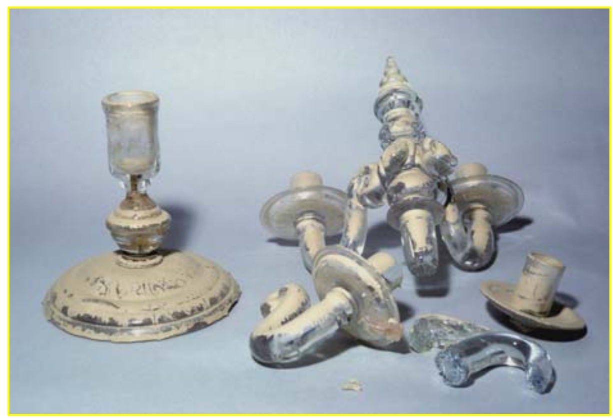

Figure 6. Chandelier, damaged and mud-covered after the Corning flood of 1972 (CMOG 60.2.39).

Materials and Techniques for Cleaning

The removal of adhesives, tapes, and labels involve well-published conservation treatments (Navarro 1997), but basic cleaning is a different problem. Glasses that are in good condition and are not sensitive to water (see above), can easily and efficiently washed with soap and tap water. Ideally, washing should be done in a plastic sink (Fig. 7). Polypropylene sinks are available, and a standard size is 30” long x 24” wide x 8” deep, not counting the 24 x 30 inch drainboard (available from McMaster-Carr, see Suppliers). The sink should also have a long gooseneck faucet with wide handles, and even a separately plumbed sprayer. A supply of pure water is required, and a simple solution to this is to place close to the sink a large polypropylene tank attached to a deionizing column (see Fig. 7).

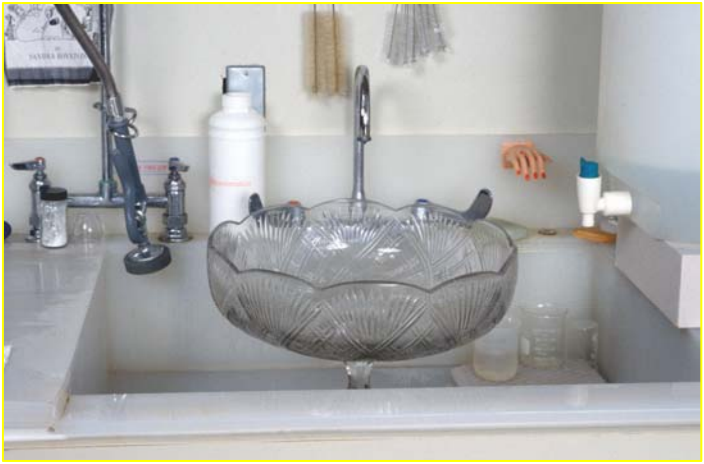

Figure 7. Polypropylene sink, with sprayer on the left, deionized water tank on the right.

The large sink provides ample working space, so that even large glasses can be completely washed and rinsed. A plastic sink will not prevent glass from breaking if it is dropped heavily, but it will minimize the risk. Polypropylene is certainly better than stainless steel, where one tap against the side, even a gentle one, will break most glasses. If it is not possible to purchase a plastic sink, one should at the very least use a large shallow plastic bucket or tub inside a metal sink.

Gloves should not be worn when washing glass (or even handling most dry glass, with the two exceptions of acid-etched and most pâte-de-verre glasses, which are extremely sensitive to staining from oils). Glass is slippery even when dry; once covered with soap it is even more slippery. A conservation grade detergent should be used, such as Triton XL-80 (see Suppliers). The detergent should be diluted with water to approximately 15:1, but the dilution ratio is not critical. Other clear liquid detergents may be used, but one should avoid powdered detergents, and anything that has color, perfumes and/or ammonia.

Cleaning can be done, by rinsing, dipping, brushing, or swabbing. This depends on the shape of the glass, and how strong/stable it is. A Venetian goblet is probably best cleaned with soft toweling, either a cut-up 100% cotton diaper or soft paper toweling, both of which are even softer when wet. Brushes or small bits of cut-up sponges are also useful, as is a large curved bottle brush with very soft, natural soft bristles and a plastic handle (available from Fisher Scientific, see Suppliers). Alternatively, a soft paintbrush may be used, but one should be sure to tape over the metal ferrule. Straight brushes are more difficult to use, as one needs to keep the bristles aimed at what is being cleaned.

Cleaning should begin with warm tap water, brushing or swabbing with soap, followed by rinsing in tap water. The glass is then thoroughly rinsed in deionized (or distilled) water. A final rinse in pure water is critical to complete cleaning, as there enough minerals (dissolved and undissolved) in tap water to create little white spots on the glass upon drying. The glass can then be lightly towel-dried, with soft, lint-free, paper toweling. Bottles and decanters, if they are narrow-necked, can be drained and then a small amount of acetone used for a final rinse on the inside. The acetone combines with any remaining water, and the bottle can be drained again, ensuring complete and even drying. The acetone/water mixture also dries faster than just water. Stoppers should not be re-inserted in a bottle or decanter until the bottle is completely dry. Even then, a small slip of thin acid-free mat board, or a small piece of thick Mylar should be inserted between the stopper and the bottle, to prevent a complete seal.

Cleaning and stability

How often should glasses be cleaned? The answer to that is "probably only once", perhaps for the entire lifetime of the glass. In a stable, controlled environment with the humidity around 45%, the glass will get dusty, but the dust can be vacuumed or dusted away. Glasses should never be washed in a dishwasher, or the glass will end up cloudy and etched in just a few years (Fig. 8). The extremely hot water (usually re-heated) and hot soap (a strong alkali) rapidly attacks the silica of the glass and within a few years glasses become irreversibly cloudy and etched (microscopically).

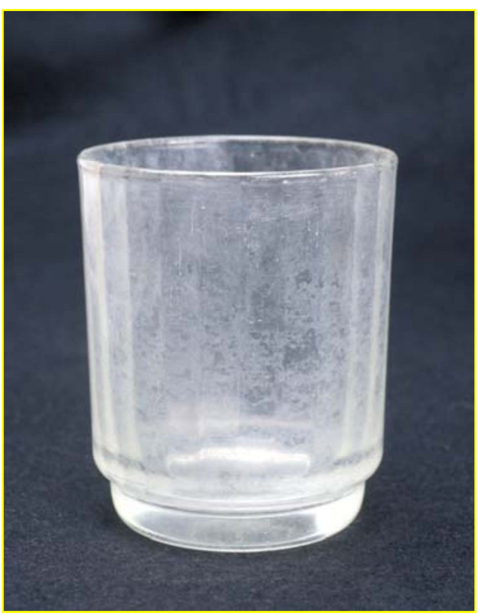

Figure 8. Modern juice glass after approximately five years of cleaning in a dishwasher.

Figure 9. Cloudy foot on a glass goblet, showing the initial stage of crizzling (CMOG 61.3.135).

The most serious problem involves the storage of glasses in an uncontrolled environment, including silica-soda-lime glasses, lead glasses, borosilicate glasses, and glasses with unstable or modified compositions. The terms "crizzling", "weeping", or "sick glass" are familiar to most conservators, and they refer primarily to the small group of 16^{th}-19^{th} century glasses that have unusually high alkali compositions, which have visibly begun to deteriorate since manufacture.

Crizzling can be categorized into several phases or stages. Initially the glass looks cloudy or hazy (Fig. 9), but the haziness will not wash off. The glass may also exhibit little white dots or even crystals on the surface if the humidity is under 45%. As soon as the humidity goes up into the upper 50s, all the dot or crystals become liquid, and sometimes the entire surface can be wet or "weeping" (Fig. 10). This is a result of the alkali in the glass leaching to the surface under high humidity conditions. Alkalies are extremely hygroscopic, and are naturally drawn to the surface of glasses, particularly if there is a compositional imbalance.

Figure 10. Wet, "weeping" wine glass (CMOG, no number).

Figure 11. Cracked Venetian goblet with advanced crizzling (CMOG 59.3.20).

"Weeping" then, is simply the high-humidity phase of a glass that is in the beginning stage of "crizzling". Over many years (or sometimes it takes decades, or even centuries), the glass begins to crack – microscopically at first, and then visibly to the naked eye (Fig. 11). Eventually, the cracking gets deeper into the glass until the glass is so structurally weak that it breaks (Fig. 12).

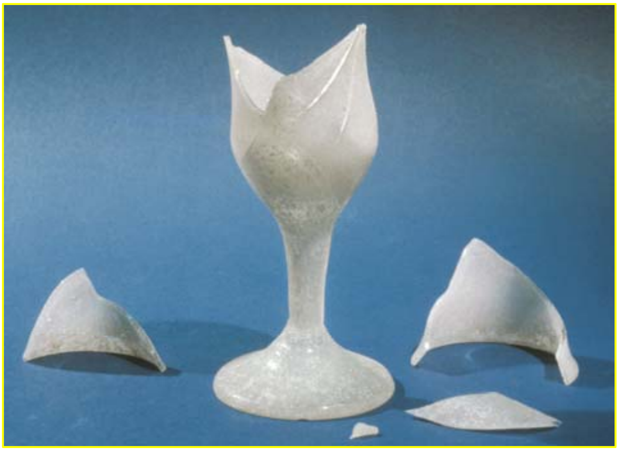

Figure 12. Structural failure of a severely crizzled glass goblet (CMOG, no number).

The primary cause of the deterioration is the high humidity, which over time leaches the alkali in the glass to the surface. If the high humidity is maintained over a prolonged period (year after year, decade after decade), the alkali can be seen as droplets, and eventually will pool or drip, thus creating the "weeping" phenomenon. If the alkali is not removed from the surface it will eventually attack the silica, thus freeing up more alkali, and causing the glass to develop cracks, or "crizzling". Fluctuations in humidity can result in the glass cracking further, and/or the droplets drying out and forming "salt crystals". The problem becomes worse if the glass is sealed in some manner and the moisture is trapped against one surface, such as in a stoppered decanter, where moisture trapped on the inside sets up a microclimate with a humidity approaching 100%.

Therefore, the leaching of alkali, or hydration of the alkali in the glass, and eventual cracking or crizzling of the glass, all occur as a result of the cycling between high and low humidity. Crizzling can occur on the interiors of glass vases, decanters, cover glasses for biological specimens, cover glasses or "crystals" of clocks and watches, on the inside cover glass of daguerrotypes, miniatures, prints and drawings. It also can occur underneath labels applied to glass, on the insides of thermopane windows, and even the original 1950's glass pane housings of the Declaration of Independence and Bill of Rights, recently redone for this very reason.

This deterioration phenomenon is most common in 16th-19th century glasses that have unstable compositions (usually low lime, high alkali), but given the examples above, it can also occur in stable glasses, owing to the microclimate created. Interestingly, the glass, or side of the glass, that is NOT exposed to high humidity (e.g., the outside of a decanter or the outside of a cover glass or clock crystal), generally does not show this problem, simply because air movement and occasional cleaning prevent it from happening. Current research (Eremin, et al., 2005, Grzywacz, et al., 1994), also indicates that the problem can be exacerbated by airborne pollutants, such as those found in wooden storage cabinets. Moderately low humidity, around 40-45% virtually stops the weeping/crizzling, but this is difficult to achieve in private collections. The humidity should never be dropped below 30%, as glasses that have already begun to hydrate and crack will develop even worse cracking.

Some exceptions and problems continue to exist. Glasses with very poor compositions will require even more careful monitoring and climate-controlled storage. This is especially true of some enamels, which may suffer more from dehydration than from hydration (T. Weisser 2004). Weisser noted that the early Limoges enamels in the Walters Art Museum were especially sensitive to cracking at low humidity and that 50% might be better for preserving their transparency and condition (T. Weisser, 1998). However, unstable Venetian glasses of the 16th century have been seen to hydrate in The Corning Museum of Glass at just above 50%. More research is needed to identify the actual compositions of these unstable glasses so that we can better know at what conditions they are best stored. Glasses that show recurring hydration, evidenced by a slimy or slippery surface, and recurring cloudiness, may need washing, or at least rinsing, more frequently, possibly every 10-20 years.

The real reason to clean glass, therefore, is to keep it stable. Most clean glasses, if stored in a stable environment between 40-50 % RH, should remain stable indefintely.

Recommendations for Display and Storage of Glass Objects

Dr. Robert Brill, Research Scientist at the Corning Museum of Glass, recommends that glass be displayed and stored between 45 - 50 % RH, plus/minus 5%, with as little fluctuation as possible (Brill 1975; Brill, et al., 1998). He further recommends that the humidity should not go below 40% for more than 5 days, not below 35% for more than one day, and should never go below 25%. For glasses that already show signs of crizzling the storage should be maintained as close to 42% as possible, and as long as they are strong enough they should also be washed once, before going into storage. The humidity control is critical to the long-term preservation of glass. The temperature is not as critical, unless it affects the humidity, which it often can do in intense spotlighting. Rapid environmental changes should also be avoided.

The humidity is best controlled through the building's HVAC system. Controlling the climate in individual cases is not often practical or cost effective, especially for large collections. It would be virtually impossible to maintain appropriate humidity levels for individual cases in the Corning Museum of Glass, which has a collection of over 40,000 glasses. In addition, because air movement prevents the establishment of a high humidity microclimate, more air movement is recommended. This can be achieved through higher air-exchange in the HVAC system, or by individually installing fans at the tops or bottoms of cases. This will prevent any alkali build-up on the surface of a glass.

Conclusion

Cleaning is an important step in the long-term preservation of glass. Cleaning also enhances the appearance of glass, whether it is for personal pleasure, study and research, or museum display

(Figs. 13, 14). There are numerous types of glasses, but the silica-soda-lime glasses make up approximately 90% of all types from antiquity to the present, from Roman vessels to modern window panes. These glasses are generally thought to be very stable, but they will slowly deteriorate (through weeping or crizzling) over decades and centuries of prolonged exposure to high humidity, grime and pollution.

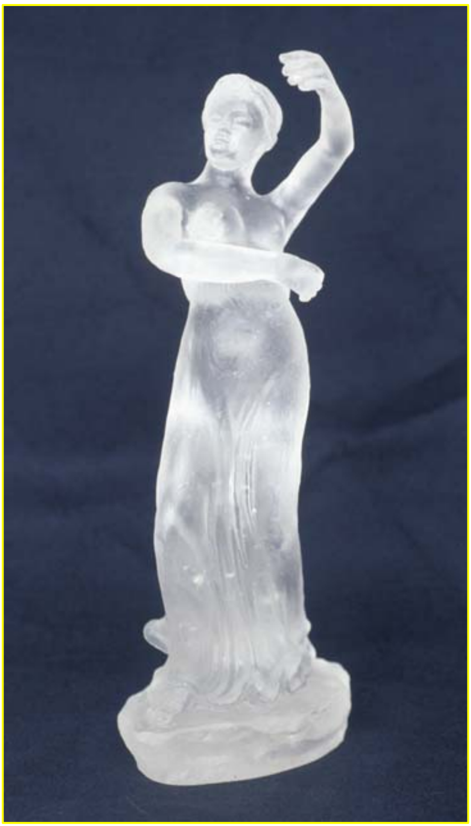

Figure 13. Glass sculpture (cf. Fig. 5) after adhesive removal, cleaning, repair and restoration (CMOG 59.4.426).

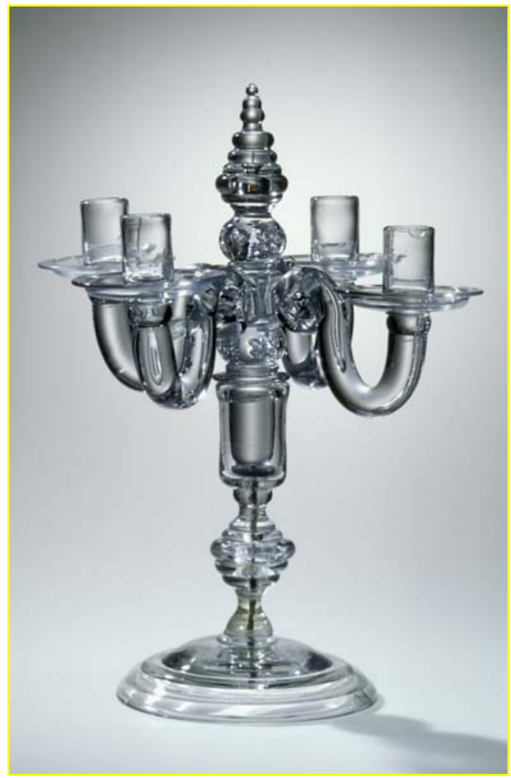

Figure 14. Chandelier (cf. Fig. 6) after cleaning and repair (CMOG 60-2-39).

Glasses that are subjected to prolonged storage in high humidity (over 55% RH) will begin to hydrate and the alkali in the glass will come to the surface. Unless this is cleaned off, eventually the alkali will start to dissolve the silica in the glass. In addition, the removal of decades of cigarette smoke, grease and grime from handling, and more recently, pollution and off-gassing from improper storage cabinets, will contribute significantly to the prolonged stability of all glasses.

Most glasses can be washed using a detergent and water, as long as the glass is sound and in good condition. Warm tap water can be used for the initial washing, followed by rinsing with deionized or distilled water. A dilute conservation-grade detergent is recommended, such as Triton XL-80N. Cleaners or detergents that contain perfumes or ammonia should be avoided. Soft brushes and soft cotton toweling are recommended; and glass objects should never be run through the dishwasher, nor cleaned with abrasive sponges or cleaners.

A simple washing, even once in the lifetime of a glass, will protect the glass for decades, if not centuries.

Suppliers

Polypropylene Lab sink:
McMaster-Carr Supply Company, 330-342-3330, (www.mcmaster.com) .

Triton XL-80:
Conservation Resources, 8000-H Forbes Place, Springfield, VA 22151, 1-800-634-6932, (www.conservationresources.com)

Fisherbrand flexible-handle brushes:
Fisher Scientific, 1-800-766-7000, (www.fishersci.com).

Acknowledments

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